CITY OF TIGARD

GEOGRAPHIC INFORMATION SYSTEM (GIS)

STRATEGIC PLAN

November 2006
Financial and Information Services Department

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I see, as in a map, the end of all….
-Richard III, Shakespeare

Introduction

Overview

A Geographic Information System (GIS) is proven technology that has been in use for several decades by many government agencies and other organizations as a decision support tool and information management system. GIS provides the capability to collect, manage, manipulate, analyze, and distribute information that is tied to a location, and it layers that information in a map-based environment to provide a better visual image of location, patterns and relationships. GIS is enabling and core technology that touches numerous business processes, systems, data, and other applications. As such, it is an integral part of the computing infrastructure that contributes to the success of a City's service delivery and operations.

Recognizing the importance of GIS, the City began using GIS in 1989, mostly within specific departments, to support analysis and maintenance of its base maps. As the interest and value of GIS capabilities became more apparent to more departments and the desire to improve customer service and other business processes with GIS technology increased, it was realized a strategic and comprehensive approach towards GIS was necessary in order to truly achieve the efficiencies and benefits of such a system supporting all departments.

This GIS Strategic Plan will serve as a road map for the next three years allowing the City to better leverage its GIS investments and to ensure future priorities for GIS technology and related business processes are aligned with city-wide objectives. The implementation portion of the GIS Strategic Plan consists of a standard development and deployment methodology that will, when complete, achieve an enterprise GIS for the organization. The five phase approach consists of the following:

This document represents the completion of Phase 1, of the GIS Strategic Plan and lays the foundation in the form of a work plan for Phases 2 through 5.

List of Chapters

This document is organized into the following chapters:

- *Chapter 1 Background*
  Chapter 1 reviews general GIS concepts to orient the reader towards concepts, topics, and subjects discussed throughout the plan.

- *Chapter 2 Preliminary Assessment*
  This chapter reviews the current GIS environment within the City of Tigard, including issues, and trends, and opportunities.

- *Chapter 3 Vision, Mission, Goals & Objectives*
  Chapter 3 establishes the vision, mission, goals, and objectives for Tigard's enterprise GIS, including measures of success.

- *Chapter 4 Organizational Structure and Staffing*
  Chapter 4 reviews organizational planning issues associated with developing an enterprise GIS, including staff requirements and roles and responsibilities.

- *Chapter 5 GIS Cost Benefit Analysis*
  This chapter provides an overview and analysis of tangible and intangible benefits of GIS and evaluates forecasted GIS costs and benefits for the organization.

- *Chapter 6 Cost Estimate & Finance Strategy*
  Chapter 6 includes a financial analysis of the implementation costs for the initial enterprise GIS infrastructure.

- *Chapter 7 Schedule*
  Chapter 7 contains the overall enterprise GIS development schedule.

- *Chapter 8 GIS Work Plan Outline*
  Chapter 8 contains the preliminary work plan outline and corresponding major task areas of the 5 phase development and deployment process.

Report Summary

Sections covered in the Report Summary:

- Synopsis
- Introduction
- Statement of Business Problem
- Recommended Strategic Initiatives
- Intended Users
- Vision, Mission, Goals, Objectives, Measure of Success
- Project Approach
- Deliverables
- Return on Investment
- Financing Strategy
- Contract Support
- Project Staffing
- Staffing Recommendations
- Risks
- Limitations

Synopsis

Governments depend on data to provide services to the community. Interestingly, a large majority of this data is location-based. Computer systems that can manage location-based information provide a unique *geographic advantage*.

There is wide understanding and acceptance within the City of Tigard that a Geographic Information System (GIS) -a proven information technology, is essential to delivering a broad spectrum of the City's services involving location-based information.

What essentially remains is a road map to guide the organization to a successful implementation of GIS. This document represents that road map in the form a three year GIS Strategic Plan for the City of Tigard.

Introduction

A Geographic Information System (GIS) is defined as "an information system that is used to input, store, retrieve, manipulate, analyze and output geographically referenced data (location-based), in order to support decision making for planning and management of land use, natural resources, environment, transportation, urban facilities, and other administrative records."

In the last decade, the City of Tigard has used GIS for mapping in Planning and Engineering. However, until now, GIS has developed as these department's needs arose and the responsibility for development and planning of these systems as been

generally limited to those departments. Additionally, the GIS application that has been in use for nearly ten years is significantly past its end of lifecycle.

Up to this point, there has been no strategic direction for the development and deployment of GIS technology, including a set of standards that facilitates developing and sharing of information among departments and applications. Likewise, there exists no defined means to identify and resolve technical and institutional barriers to successful GIS deployment and to plan for technical, staffing, and organizational development as well as the resources necessary to support GIS effectively.

The purpose of the GIS Strategic Plan is to assert a holistic approach towards the utilization of GIS technology and to establish a unified vision for the organization to further invest in GIS technology in an effective, efficient, and coordinated manner.

Statement of Business Problem

The City of Tigard's GIS is an information asset and valuable decision support tool for providing efficient government service to the community. The City's investment in GIS technology has been limited to department level activities, with essentially no corporate oversight and strategic direction to adequately guide investment and improve business processes. The result is that there are numerous redundant databases and work flows that could be streamlined by the use of a city-wide GIS.

For approximately 10 years, the City's primary GIS application MAGIC has provided staff access to the City's map base; however, the system is well past its end of lifecycle and is in need of replacement. The system is based on old unsupported software and programming technology. The older technology is also extremely inflexible in terms of integrating with other business systems.

With a strong city-wide demand to improve work flow and business processes by integrating map-based information with corporate business systems, the City is at an important crossroad with its aging GIS technology. The City will continue to face increasing costs to maintain an inefficient and outdated GIS with extremely limited expansion capabilities serving only a couple of departments, or it can develop a city-wide, or enterprise GIS, and institute an organizational model that is highly efficient; A GIS that:

- Provides a more efficient and cost-effective means for managing, maintaining, and monitoring geographic data;
- Improves access to the City's geographic information, as well to other agencies through data sharing opportunities;
- Maximizes existing resources devoted to the management and maintenance of geographic data;
- Reduces repetitive and redundant maintenance of GIS related data;
- Improves security, reliability, quality, and performance of GIS for staff and the community;
- Provides a corporate strategic direction for GIS investment and activities;

- Improves workflow in and between departments;
- Integrates with existing and planned business systems;
- Delivers GIS related services to the community that reduces cost and adds value.

Recommended Strategic Initiatives

In order to accomplish an enterprise GIS and create a more efficient model for the City's geographic information, the following strategic initiatives are recommended:

- *Develop and Implement an Enterprise GIS Strategic Plan*
  A strategic plan is the guiding framework document for establishing the initial vision, goals, objectives, requirements, and other parameters associated with implementing an enterprise GIS.

- *Conduct a Pilot Project*
  Given the magnitude of the investment for an enterprise GIS and the timeline associated with deployment of the technology, a pilot project is an excellent opportunity to early on merge the planning stages with the implementation stages of project development and provide a tangible product that will serve as a way to educate stakeholders and build support for project.

- *Establish System Architecture Hardware/Software Environment*
  The foundation of an enterprise GIS is its architecture design, hardware environment and suite of software. The system architecture should reflect the needs and requirements defined in the strategic plan, including finding a suitable replacement for MAGIC.

- *Develop Map Base*
  The foundation of the enterprise database is a map base and associated data models. Databases can be the most time-consuming and expensive part of an enterprise project. Development of a map base will require careful evaluation, needs assessment, and prioritization.

- *Develop Standards and Procedures*
  A GIS is more than hardware, software, and data. It must also include standards and procedures that enable the data and technology components of the system to work consistently and efficiently. In a municipality with different departments and varying GIS requirements, standards and procedures will be critical in ensuring the system works correctly.

- *Web-based Mapping*
  The City's current application for delivering mapping capabilities to employees (MAGIC) is outdated and inhibits further integration. In order to ensure an efficient integration with other business systems, use a standards based open architecture development environment, and improve mapping services to the community, a web-based mapping application is needed.

- *Priority Application Development/Integration*
  The enterprise GIS will need to have the appropriate environment to allow the system to be enhanced over time as systems are replaced or upgraded. This environment should be flexible and low-cost to allow ease of integration. Application development and integration capability need to be designed into the system early on during the design phase. Initial application development and integration efforts should focus on priority applications.

- *Develop Training Plan*
  The City will also need to develop a training plan so that the knowledge base within the organization is at established levels and users receive the appropriate amount of training relative to the level of interaction they have with the system.

- *Transition to Program*
  In an enterprise environment, a GIS cannot be implemented and left without leadership, coordination, support, and the ability to develop the system. Some level of program management will need to be established in order to ensure continuing success, value, and operational efficiencies.

Vision, Goals, Objectives, Measures of Success

A critical element to developing an enterprise GIS is to establish a vision, followed by measurable goals and objectives. Goals and objectives create a mutual framework for stakeholders and will drive subsequent decision-making throughout the implementation of the enterprise GIS. The vision statement and goals, objectives, and measures of success were developed by the GIS Steering Committee and are contained within this document. See the Goals and Objectives Matrix at the end of this summary. Refer to Chapter 3 for the Measures of Success.

Intended Users of GIS

Under the enterprise model, GIS will be extended to a much broader group of users. Essentially, all Tigard employees and the public will have some level of access to the enterprise GIS. Depending on skill level, needs, and administrative rights, GIS will be tailored to three basic groups. These include: Administrator, Analysts, and Viewers. The Administrator accesses GIS primarily for system administration and data management. The Analysts access GIS for high end map production, analytical work, and data maintenance. The Viewers primarily browse GIS data performing queries, look ups, report generation, and simple map production.

Project Approach

GIS is often viewed as a technology solution, and while that is partially true, enterprising a GIS involves considerable planning, designing, and development in order to realize the benefits of such a system. It therefore takes more time and effort to successfully implement. The GIS Strategic Plan identifies a five-phase approach to achieve an enterprise system. Through this logical series of phases, all departments and relevant business processes will be systematically evaluated in terms of their requirements and needs for GIS as part of their work flow. From this a comprehensive solution will be designed and implemented. The five phases include:

Deliverables

The enterprise GIS implementation will result in distinct deliverables. The following lists the expected end products.

- *Base Map/Corporate Data Model*
  The base map generally consists of streets, parcels and other fundamental layers. Because the base map will serve as the point of reference when creating other spatial databases, it will have the highest level of accuracy requirements. The corporate model will provide the overall spatial framework for how geospatial data is organized, managed, maintained and collected within the City.

- *Software/Hardware*
  It is anticipated a suite of software and hardware will be necessary to successfully deploy the enterprise GIS. While the City all ready has some desktop application of GIS, the existing inventory will be evaluated in terms of its ability to meet the business requirements found during the needs assessment phase. Where there are gaps, new software will be required. In addition, it is anticipated that hardware purchases in the form of servers will be necessary to adequately store the centralized database.

- *Web-based Mapping*
  One of the anticipated major components of the enterprise GIS will be a web-based application, or series of applications that will replace the current outdated MAGIC application and deliver GIS functionality via the web. This includes applications tailored for City staff as well as to the general public via the City internet site.

- *Standards/Procedures*
  Promoting city-wide standards will ensure consistency, reliability, and quality in the City's GIS. Promoting procedures will ensure a consistent approach towards

GIS data maintenance and application development and in the long run reduce overall costs. Types of standards and procedures generally consist of metadata standards, data development/maintenance standards, software standards and application development environment standards.

- *Application Development Capability*
  It will not be possible to have all GIS requirements satisfied through "commercial-off-the-shelf" (COTS) applications; therefore, it will be necessary to establish an application development environment to address additional requirements as new systems are developed and requirements are updated. This application development environment is anticipated to be one that is scalable and easily customizable.

- *Training*
  A training program will be established in order to ensure an adequate GIS knowledge base is established and continues as necessary for the organization. The training program will be consistent with the proposed user groups (Administrator, Analyst, and Viewer) as defined in Chapter 3.

- *GIS Program*
  After the initial enterprise deployment, GIS will transition into a program. The program will help promote and coordinate the use of GIS technology, especially those projects which are critical to improving overall efficiency and effectiveness of business processes and city services. In addition, the program will help departments with GIS development, standards, training, and guide overall system performance.

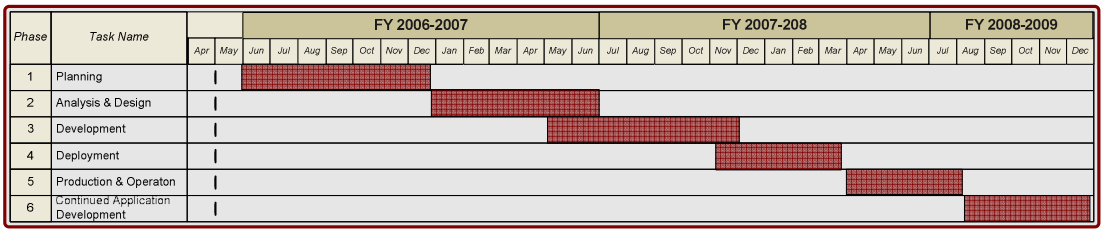
Return on Investment

Implementation of an enterprise GIS will produce both quantitative and qualitative benefits. The majority of the quantitative benefits will be time savings as a result of streamlining business processes involving geographic data, allowing staff to focus on other critical elements of their job duties while improving the delivery of services to the community.

An analysis of the efficiency and effectiveness of a GIS implementation relative to current business processes showed that a majority of they City's business processes would have a high likelihood of increased efficiency. As well, there are numerous intangible benefits that cannot be immediately quantified in financial terms, but are nonetheless of high value for the City. These include improved access to geographic data, protection of assets, data security, and public safety, especially in regards to emergency response.

Proposed Schedule

Development and deployment of the core enterprise GIS is expected to occur over the next 3 years. This assumes that the adequate funding is available for completion of the components of the work plan.



Financing Strategy

The City's assessment of the total three year cost to implement comprehensive core GIS infrastructure is estimated at $759, 250. The proposed strategy involves an investment spread out over three years, which will result in funding being available during the course of the proposed project schedule (see Table below).

Once the three year investment period is complete, the GIS program will be integrated into normal budgeting within the IT Division.

GIS COSTS FORECAST						
Costs (1)	**FY06/07**	**FY07/08**	**FY08/09**	**FY09/10**	**FY10/11**	**Totals**
Implementation						
Phase 1 Strategy & Planning Phase 2 Analysis & Design (Partial)	$125,900					$125,900
Phase 2 (Remaining) Phase 3 Development Phase 4 Deployment		$528,350				$528,350
Phase 5 Production/Operation			$105,000			$105,000
Total Implementation Costs						$759,250
Maintenance (Program Costs)						
GIS Program	$101,500	$122,790	$184,987	$215,536	$247,052	$871,865
Total Costs	**$227,400**	**$651,140**	**$289,987**	**$215,536**	**$247,052**	**$1,631,115**

Project Staffing

This year, Council approved the hiring of a GIS Coordinator to develop the City's enterprise GIS. This position will serve as the primary project manager/coordinator role through the development and deployment of the enterprise GIS, and then transition into a program management role once the system is in place.

During the implementation of the enterprise GIS, a Steering Committee will provide review and input on key decision-making areas during the project. The Steering Committee will be composed of department representatives. Members will meet once a month during the project.

Contract Support

In addition to expertise and staffing within the City, technical expertise will be required through contracting services to assist in some of the areas of needs assessment, system architecture design, database development, application development, and deployment. Cost of contract support is factored into the overall implementation cost estimate. Scopes of work will stem from the GIS Work Plan (see Chapter 8).

Staffing Recommendations

To adequately provide support for the enterprise GIS, especially as it grows and becomes more integrated with other business systems and processes, a GIS Analyst position is recommended to be created and filled within 2-3 years. This position will be critical in providing support in the functional areas of an enterprise GIS program operation, including system support and application development.

Risks

As with any major technology deployment there are risks associated with the implementation of an enterprise GIS. Fortunately, the City's delay in investing in enterprise GIS technology has put it in the position where it will not be developing 'bleeding-edge' technology. GIS technology is widely used and accepted, especially in the Portland metropolitan area. There are a number of governmental venues for support, both formal and informal, that the City can utilize during its implementation of GIS. In addition, the technology the City will be investing in is based on standardized programming languages, open architecture, and will be primarily Commercial-Off-The-Shelf (COTS) software not requiring significant customization.

Most of the risk the City will face will be of its own during development and management of the system. These include:

- *Data Conversion Costs*
  Data conversion is usually the most expensive component of a GIS implementation. Estimates in this Strategic Plan are based on limited review of the current state of the City's data, in particular Public Works utility data. The Needs Assessment will provide a more accurate picture of the magnitude of the conversion effort. If it is found that the data conversion or data collection effort will be more considerable, then the cost-estimates may have to be refined.

- *Department Conflicts/Scope Creep*
  In the enterprise GIS model, one comprehensive system will be designed to serve all departments. In such a model, there will inevitably be varying opinions and conflicts in how the system is designed. While this is typical in any multi-department endeavor, during the enterprise GIS implementation it will be particularly important to manage the scope of work closely and develop change management procedures to ensure there are not excessive delays, excessive costs, or incidences of scope creep broadening the project beyond is original intent.

- *On-going Support/Coordination Requirement*
  An enterprise GIS will not persist, and subsequently not provide the intended return on investment, if it does not receive on-going management, coordination, and staffing as identified in this document. The technology is expensive and can provide significant cost-savings; however, it takes special and devoted personnel to ensure the savings are obtained.

- *Complex Technology*
  While the front end of many GIS are becoming more simplified and easy to use for the casual user, it is important to realize the technology behind the GIS is becoming increasingly complex. The City will need to acknowledge that certain skill sets identified in this GIS Strategic Plan will be required to keep the system at a certain level of operation. If these skill sets are not available, then the benefits again are likely not to be obtained. The GIS Strategic Plan will become an important component in establishing the required skill sets to sufficiently maintain the enterprise GIS (See Chapter 4 GIS Organizational Structure and Staffing).

Limitations

The focus of the enterprise GIS will be on designing a system and program that meets the needs of the City of Tigard. During the development process, there will likely be various issues uncovered that deal with the broader aspects of the information management and technology needs of the City, possibly related to GIS and possibly not.

The enterprise GIS implementation, while comprehensive, cannot fully address all information technology issues of the City.

In addition, rapidly changing technology can make plans obsolete before they can be realized. Therefore, this report will provide a framework for a GIS implementation strategy that will be flexible enough to change with the technology to the extent practical.

Furthermore, the enterprise GIS implementation will attempt to take the needs of all City departments into consideration. Key data sources will be discussed and recommended for data conversion and/or creation. Suggestions will be provided on ways that the City can incorporate a wide variety of data sources into its GIS. However, in the end not all data sources and GIS needs may be incorporated into the initial implementation.

Summary

The City does not need to be sold on the value of GIS as a new technology, having used it steadily for over 15 years. Despite the successes so far however, the full utility for what GIS can provide has not been fully realized up to this point. Aging systems, a lack of data access, incorrect address information, duplication of efforts, lack of strategic planning, and shifting priorities all characterize challenges of the current GIS environment. All of these issues speak to a larger need for a results-oriented enterprise GIS focus that can remain in place over a period of time to follow-through and deliver results.

The Enterprise GIS described in this document will provide such a focus and help the City to realize value from GIS technology beyond what any one department or individual can achieve. In truth, the City has already come to realize the value of this message by committing to the GIS strategic planning process and the development of this plan, a logical first step. Great efforts have been exerted to compile and develop a truly collaborative plan for GIS that has the consensual support of the individuals across the city who will later be participate in the plan implementation.

The City has a unique opportunity before it to seize upon this momentum and develop a GIS infrastructure that can be part of a suite of mission critical decision support tools. The impacts that would be felt to core business processes, internal efficiency and citizen service are unquestionably important and will have positive impact on City governance.

With Council support and approval for the recommendations in this document, the City will have taken the next step towards realizing the full potential for what GIS can provide to government and the community it serves.

City of Tigard Enterprise Geographic Information System (GIS) –Goals & Objectives

Vision

The Geographic Advantage

"Provide a robust and high quality geographic information system that empowers users to efficiently manage and maintain accurate, reliable, and consistent geographic data, and to easily and quickly obtain information in various formats on demand."

Goals

Goal 1 GIS Quality	Goal 2 Ease of Access	Goal 3 Integrated GIS	Goal 4 GIS Training	Goal 5 GIS Sustainability
Accurate, consistent, and complete core geographic database.	Easy and common access to geographic information.	Integration of GIS with other core business processes.	GIS knowledge base Improved within the organization.	Cost-effective and sustainable use of GIS technology throughout the organization.

Objectives

Objective 1.1: Establish a **centrally managed geographic database** usable by multiple departments. *Objective 1.2*: Establish and implement a **system design** for enterprise GIS architecture. *Objective 1.3:* Establish **standards and procedures** for the development and maintenance of geospatial data. *Objective 1.4:* Establish **standardized methods** and procedures for application development related to integration with GIS (build it once, use it over and over again).	*Objective 2.*1: Establish efficient and reliable **organization-wide access** to geospatial data. *Objective 2.2*: Promote and guide the **implementation of web based applications** that facilitate access to geographic information. *Objective 2.3:* With GIS technology, **improve public access to online city services.**	*Objective 3.1*: Promote the **integration of GIS with other business systems and programs**. *Objective 3.2*: Use **standardized technologies and techniques** in order to ensure more seamless technology integration.	*Objective 4.1:* Facilitate a **GIS clearinghouse for sharing ideas**, discussions, and information about GIS related topics. *Objective 4.2:* Provide GIS **training opportunities** to staff to empower them to fully utilize GIS functionality. *Objective 4.3:* Establish a **GIS user group network** within the organization to help facilitate and grow the institutional knowledge base.	*Objective 5.1*: Establish **centralized review and coordination** of GIS resources, infrastructure and initiatives. Objective 5.2: Develop an **on-going GIS program** to ensure efficient use of enterprise GIS resources.

Chapter 1 Background

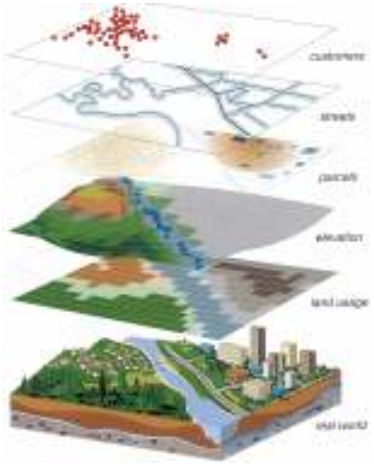
Sections covered in this Chapter:

- What is a GIS?
- Spatial Data
- Descriptive Data
- The Geographic Data Model
- Benefits of a GIS
- Enterprise GIS Benefits

What is a GIS?

A Geographic Information System (GIS) is a computer technology that combines geographic data (i.e., the location of features in our environment both natural and man-made) and other types of descriptive information (e.g., names and addresses) to generate visual maps and reports (Looney, 2000).

GIS stores information about the world as a collection of thematic layers that can be linked together by geography. The simple but extremely powerful and versatile concept has proven to be invaluable for many problem solving activities such as managing underground utilities, mapping sensitive environmental areas, modeling the economic impacts of development restrictions, and the planning cities and regions.



Graphic provided courtesy of Environmental Systems Research Institute

A GIS enables a person to visualize patterns, relationships, and trends. This process gives an entirely new perspective to data analysis in map form that cannot be seen in a table or list format. A GIS is not just about maps however; but consists of a collection of hardware, software, data, skilled personnel, and the methods to manage how the technology is applied.

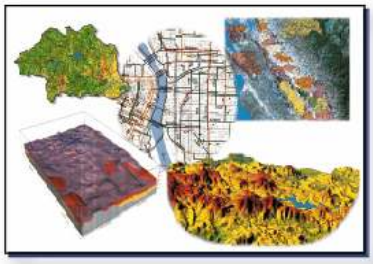
With GIS, one can:

- Map where things are
- Identify what exists at a certain location
- Determine if certain conditions are satisfied
- Map change over time
- Discern spatial patterns and relationships
- Conduct ‘what if?’ scenarios and model future conditions

Spatial Data

At the very core of a GIS is spatial, or geographic data. Spatial data is the representation of the geography in our environment by modeling abstract forms, most often in the form of features on maps.

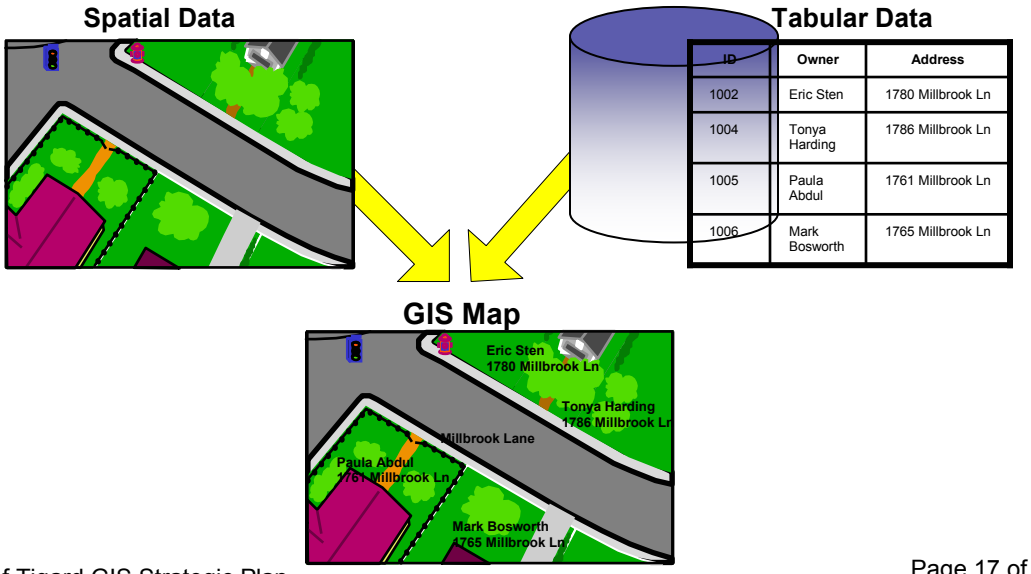
Most of us probably take for granted our intuitive understanding of spatial data. For example, when we unfold a road map, we know streets will probably be red or black lines, that rivers will be blue lines or polygons, and that a dot represents the location of something. In a GIS environment, formal models govern the representation of theses features and allow for a highly sophisticated environment to store, display, analyze, and maintain that information. This modeling is not limited to mapping discrete features such as streets or rivers, but encompasses other representations of geography through such models of surfaces (e.g., slope) , networks (such as a power system), images (an aerial photo), and 3 Dimensional (3D) models.



Graphic provided courtesy of Environmental Systems Research Institute

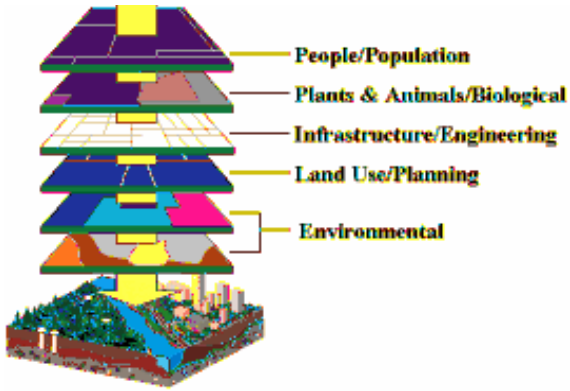
Descriptive Data

A distinct characteristic of GIS is its ability to store descriptive, or attribute data, related to features presented on a map. In GIS you can have any number of attributes values associated with features. For example, a tax lot on a map can have any number of attributes associated with it, such as ownership information, zoning, and building value. These attributes reside in a database table or can be accessed through links to other databases. As an example, for the same tax lot it is possible to associate and link to permit history of a site that may be stored in a separate database in another system. This seemingly endless ability to link to descriptive business data to mapped features give GIS an unparallel advantage to other information systems.



The Geographic Layer Model

As mentioned above, GIS stores information about our environment as a collection of thematic layers. The layer concept is what provides GIS with its display capabilities and extreme analytical potential, as it allows querying and analysis within and between layer groupings. Layers are usually a collection of logical groups, such as utility information, environmental information, and zoning information. The GIS database stores both the spatial data (where something occurs) and the attribute data (characteristics of the data) for all of the features shown on each layer. This layer concept is especially valuable in terms of organizing and managing large data sets.



Benefits of a GIS

Information from a GIS lets you see patterns and relationships in geographic data not usually seen in tables and lists. GIS provides insight to a place, helps you focus actions, or helps you choose the best options. The benefits of a GIS are vast. The following are some examples of the benefits a GIS.

Visualization & Analysis –Mapping Where Things are
Mapping where things are lets you find places that have the features you are looking for and to see where to take action. For example:

- *Find a feature*-People use maps to see where or what an individual feature is.
- *Discover patterns*-By looking at the distribution of features on the map instead of just an individual feature, you can see patterns emerge.
- *Map change/ predictive "what-if?" modeling*- Mapping change allows you to gain insight on behavior and subsequently anticipate future conditions and ask questions about what if you change things –what will the change be?

Making Maps –Consistently & Efficiently
Making maps with GIS is much more flexible than traditional manual or automated cartography approaches. A GIS creates maps from data pulled from databases. Existing paper maps can be digitized and translated into the GIS as well. The GIS database can be both continuous and scale free. Map products can then be created centered on any location, at any scale, and showing selected information symbolized effectively to highlight specific characteristics. A map can be created anytime, to any scale, over and over for anyone.

Efficient Data Storage
In a GIS, tabular, or descriptive data, and the actual physical representation on a map are incorporated together for easy access. One doesn't have to have a hard copy map in one drawer and a notebook with descriptions in another. Information is combined and greatly improves analytical abilities, especially between data that traditionally may have been stored separated, such as utility data and environmental data.

Communicate Information –Fast
We are visual people. We quickly understand information better when maps and graphs are employed. Most people are more likely to comprehend something if it is in a map or chart, rather than in a running table of data. Combine this with the fact that 80% of data is located based (Wagner, 2006) and you have enormous opportunity to use maps as a communication tool.

Make Better Decisions
The old adage "better information leads to better decisions" is true for GIS. A GIS is not just an automated decision making system but a tool to query, analyze, and map data in support of the decision making process. For example, GIS can be used to help reach a decision about the location of development that has minimal environmental impact, is located in a low-risk area, and is close to a population center. The information can be presented succinctly and clearly in the form of a map and accompanying report, allowing decision makers to focus on the real issues rather than trying to understand the data. Because GIS products can be produced quickly, multiple scenarios can be evaluated quickly, efficiently, and effectively.

Enterprise GIS Benefits

An enterprise GIS, by definition, is a centrally managed integrated, multi-departmental system of components used to collect, organize, analyze, visualize, and disseminate geographic information using a distributed network architecture. The basic idea of an enterprise GIS is to address the needs of departments collectively instead of individually through common standards, procedures, and methodologies.

How is an enterprise GIS beneficial? Basically it includes the above mentioned benefits, but extends these capabilities to the entire organization. In an enterprise GIS, geographic information is acknowledged as a corporate asset that needs to be closely managed to ensure maximum efficiencies. For organizations the benefits of an enterprise GIS translate into:

- Improved operational efficiencies;
- Economies of scale;
- The ability to integrate geographic data seamlessly with other business systems;
- The ability to streamline workflow;
- Better accuracy, security, and integrity of geographic data;

- Improved coordination amongst departments;
- Improved distribution of geographic data;
- Improved management of the system at a programmatic level.

Chapter 2 Preliminary Assessment

Sections covered in the Chapter:

- Current GIS Environment
- Business Systems
- Technology Environment
- Business Processes
- Issues
- Opportunities
- GIS Industry Directions
- Architecture and Application Choices
- Other Cities
- Recommended Strategic Initiatives
- Recommended Focus Areas
- Project Organizational Structure

Current GIS Environment

Tigard began using GIS in 1989 to automate map production and improve its analytical capabilities. The technology has, up to now, been used primarily in the Community Development (CD), Engineering, and Public Works areas. CD uses GIS in long-range planning projects, zoning maintenance, comprehensive maps and other planning activities. GIS is heavily used in ad-hoc analysis and as a decision support tool. Public Works uses GIS primarily to find scanned schematics via indexing grid layers in GIS. Engineering assists in much of the daily maintenance of the data layers, such addresses and utilities. The Police Department has also just recently purchased an ArcGIS license to assist in analyzing crime data. Each of these departments has part time staff devoted to GIS analysis and data maintenance.

Streamlined GIS functionality is available to most city employees via a customized ArcView 3X desktop application called MAGIC (developed initially by Metro and subsequently enhanced internally). There are a number of floating licenses available which allow multiple users to access GIS data at once.

No business systems are integrated with the City's GIS. Procedures for moving business data into GIS and viewed via MAGIC usually involve manual exports (e.g. dbf tables) and join functions within the GIS application. In addition, several static map links are built into the MAGIC which allow users to view other business data on scanned images.

The current GIS within the City is a decentralized "department specific" model with each department responsible for maintaining their own data, developing their own standards and procedures, and managing their own personnel resources. Files are stored in a file-server environment as well as some individual desktop computers.

Business Systems

The City of Tigard uses several different independent business systems to perform various city functions. These systems have evolved over time to serve primarily department specific activities. They include:

Finance System
The Finance Department uses Springbrook to manage its financial system.

Permitting System
The Community Development Department uses Tidemark Software (Accela, Inc.) to manage its permitting system for building and planning. The Community Development Department is currently evaluating the feasibility of moving to Accela.

Public Works System
The Public Works Department uses various modules of Hansen to support public works functions. Hansen data has been recently migrated into a SQL database.

Integration with GIS
Integration of GIS with each of the above mentioned systems is possible; however there are numerous factors affecting the integration that will need to be assessed before design work. For example, while different third party vendors have developed GIS tools to integrate with these different business systems, the City may elect to use standardized development tools to build the interface with GIS so that the cost of integrating with each system is reduced once a standard template is developed. A thorough assessment of the integration capabilities and opportunities with the business systems with GIS will occur during Phase 2.

Technology Environment

GIS Software
The City presently uses ESRI software and intends to continue use this software suite. Other third party supporting applications (such as those that work with ArcIMS) will be considered for their compatibility with ESRI as well as other City systems.

Computer Aided Drafting
Community Development/Engineering uses AutoDesk 2002, 2006 Land Development Desktop and Civil Design for reviewing projects from consultants, street designs, public improvements, and checking of plat boundaries and other surveys. The Development Review Division within Community Development uses AutoDesk for the maintenance and assignment of addresses within the city. The Public Works Department uses CAD

for maintenance of the city owned facilities. (e.g., floor plans, location of electrical, HVAC systems).

Document Management
The City does not have a document management system in place, but is in the process of a needs assessment. Implementation is expected to occur during FY 07/08.

Database Management System
The City uses both Oracle and SQL Server databases and is in the process of moving databases from Oracle to exclusively SQL so the one relational database management system is used.

Web
The City has a support internet and intranet system.

Computers
The City is moving to primarily Dell computers with MS Windows 2000 and XP.

Business Processes

The city conducts numerous businesses processes in order to fulfill its duties of operating a municipality for the community. A significant number of these business processes involve the use of geographic data.

Below is a table identifying existing business process within the City along with the corresponding departments that potentially could benefit from use of the information. This list is meant to be a starting point and will need to be refined as the project moves forward, especially during the Needs Assessment phase. In addition, as this list is extensive it is likely that some priority mechanism will need to be used in during the initial development of core GIS infrastructure so that priority business systems are addressed first related to the enterprise GIS schedule and budget.

The circle indicates that the Department has an interest in the business process. Note that the business processes often cross departmental lines, thus multiple departments need to be involved when evaluating the particular business process.

Business Processes Involving GIS								
Business Processes	**Eng**	**Pub Work**	**Com Dev**	**PD**	**Lib**	**Admin**	**Fin**	**Other**
Infrastructure								
Address System	●	●	●	●	●	●	●	●
Critical Private Utility & Other Agency Utilities		●						
Drawing/Document Mgmt.	●	●	●	●	●	●		●
Facilities/Asset Mgmt.	●	●				●		
Parks Management		●	●					
Parking Management		●						
Pavement Mgmt.	●	●						
Street System	●	●	●	●				
Utility Mgmt.(water, sanitary, sewer)	●	●						
Planning								
Demographics/Business Geographics			●	●		●		●
Land Use Planning			●					
Permitting/Development Review	●		●					
Transportation System Plan	●		●					
Environmental								
Environmental Mapping	●	●	●			●		
Services								
Community Policing				●				●
Crime Analysis				●				
Crime Prevention				●				●
Disaster/Emergency Planning & Response		●	●	●				●
Library Services					●			
Police Patrol				●				
Public Safety				●				●
Traffic Accident Monitoring	●		●	●				
Traffic Monitoring	●							
Urban Forestry		●	●					
Administration								
Finance/Utility Billing						●		
GIS System Administration						●		

Issues

In a preliminary assessment of the City's potential to move towards an enterprise GIS model, current department use of GIS as well as the City's approach to managing geographic data were evaluated. The following summarizes some of the key issues.

- The city's GIS can be characterized by *islands of information* which have developed along departmental lines. As in many other businesses, the City's GIS evolved based on department needs rather than on a city-wide basis. Consequently these isolated islands of data exist in individual departments of an organization and prevent true integration and sharing of data. There is redundant data maintenance between systems;
- The City's primary GIS application MAGIC is well past its end of lifecycle and is in need of replacement. The system is based on old unsupported software and programming technology. The older technology is extremely inflexible in terms of integrating with other business systems.
- The City's GIS system cannot currently support an enterprise (or organization-wide) GIS, which is necessary to integrate most of the major City systems related to permits, police, finance, emergency operations, library, asset management, and work orders, as well as providing commercial and residential customers with improved customer service via a map-based interface on the City's web site;
- There is no city-wide strategy for developing, organizing, managing, and sharing, geographic data;
- Further attempts to integrate GIS under the current model would further perpetuate this uncoordinated approach towards the management of this valuable information resource;
- The island of information problem greatly inhibits the effectiveness of GIS and relational databases. GIS and relational databases inherently provide a common database environment and geographic frame of reference for data sharing, but in the case of Tigard, the islands of information often prevent effective information sharing and result in operational inefficiencies;
- The City's GIS is a combination of old and new technology. The older technology uses outdated programming and supported software;
- The City of Tigard business processes and systems have generally evolved to serve specific department needs and are thus fairly isolated and independent of one-another;
- No city-wide plan or strategy for the other business systems is in place;
- Separate databases and department-centric system planning have resulted in data redundancies, in particular addressing data;
- Current GIS formats used by the City of Tigard are incompatible with other business data. The City's ability to share information across departments. In its

current configuration, the City's GIS makes use of outdated formats and/or systems, several of which are no longer supported by vendors;

- The current decentralized GIS contains numerous inefficiencies and redundancies that could be reduced or eliminated through a centrally-managed GIS.

Opportunities

Although there are numerous issues that will need to be addressed related to moving the City towards an enterprise GIS, there are also opportunities which will facilitate its implementation. These include:

- There is a strong interest amongst departments to incorporate GIS with other business systems and processes;
- Management currently supports migrating the City's department-centric GIS to an enterprise GIS model;
- Minor legacy integration/disparate applications. The department specific evolution of GIS over the years has been limited to ESRI products and integration with other system has been nonexistent, therefore as GIS moves towards an enterprise system, 'undoing' legacy systems should not be too problematic;
- Integrating Technology. The integrative power of newer GIS applications can greatly reduce costs resulting from operational inefficiencies;
- There is opportunity to re-evaluate and streamline existing business process related to the development, use, integration, storage, and retrieval of GIS data;
- Standardized Architecture. An important component of the newer GIS technology is the ability store data in a relational database. This technology holds a promise for better management of data. Additionally, standardize programming using MS COM based development languages such as Visual Basic (VB) will provide better long term development solutions. Furthermore, both relational database management systems, object-oriented programming, and Web-based systems can provide data management and programming standards and help overcome data sharing problems;
- There is great potential to improve customer service, especially via the City's web site. Currently online GIS consists of static maps, some of which are not regularly maintained. There is a great potential to link GIS with other City services (e.g., permitting, crime data, utility info, transportation, community services) and improve customer service;
- There is potential to establish GIS as a component of the services provided by the Library (e.g., educational, research, general querying);

- There is potential to improve EOC (Emergency Operations Center) by providing better access to on-line and real-time mapped based information. This became very apparent at the recent emergency drill back in June.
- Idea sharing. Several other jurisdictions in the region have implemented enterprise GIS. There are opportunities to learn from these jurisdictions about their experiences to help ease our introduction to the change;
- Accepted technology. There is opportunity in that the enterprise model and technology planned for implementation is accepted technology and built on standardized architecture, thus risk is low.

GIS Industry Directions

GIS is a rapidly growing and transforming type of information system. Its roots began as a system that was primarily workstation based, isolated from other business systems. Over the last ten years, it has changed significantly and is now closely linked to the rapid growth of other information technology industry trends and a maturing, but still very dynamic industry. Some of these directions will play an important role in easing and facilitating the introduction of an enterprise GIS for the City of Tigard. These include:

Improved Usability of GIS
The general trend of GIS development seems to indicate that it is becoming more usable and dispersed in organizations, both pubic and private sectors. Traditionally GIS started in individual departments and served specialized functions. GIS applications required highly trained staff to operate. In recent years with the growth and maturity of GIS, it has become easier to use, more intuitive, more analytical, and more embedded with a variety of technologies, thus has become much more usable to a broader set of disciplines as well as businesses processes.

Enterprise Integration
With the growth of GIS, organizations have had to make critical business decisions in how to incorporate GIS in the larger context of the organization's information technology strategy. Increasingly GIS is being valued as integrating technology and a central piece of core technology that should be available to all users. As a result, GIS is assuming more of an enterprise role in organizations.

Standardization & Interoperability
Standardization is the reason for the success of the Internet, the World Wide Web, e-Commerce, and the emerging wireless revolution. The reason is simple: our world is going through a communications revolution on top of a computing revolution. Communication means "transmitting or exchanging through a common system of symbols, signs or behavior." Standardization means agreeing on a common system (ArcNews Online, 2000).

Service Oriented Architecture
Although not specific to GIS, Service Oriented Architecture (SOA) is closely linked to much of the explosion of interoperability and web-based GIS applications. In computing, the term SOA expresses a business-driven approach to software architecture that supports integrating the business as a set of linked, repeatable business tasks, or "services". Services are self-contained, reusable software modules with well-defined interfaces and are independent of applications and the computing platforms on which they run. SOA helps users build composite applications, which are applications that draw upon functionality from multiple sources within and beyond the enterprise to support horizontal business processes. SOA helps businesses innovate by ensuring that IT systems can adapt quickly, easily and economically to support rapidly changing business needs. SOA is largely based on a set of Web services standards (e.g., using SOAP or REST) that have gained broad acceptance over the past several years. These standards have resulted in greater interoperability and avoidance of vendor lock-in. One can implement SOA using any service-based technology (Source: Wikipedia).

GIS on the Web
GIS will continue to become more web-based. Improvements in Internet speed, cost and availability have brought about innovations in Web site technologies, such as the use of Asynchronous JavaScript and XML (AJAX), image tiling for 3D visualization, and continuous scrolling. Such technologies are improving the usability and response times of Internet sites and are an attempt to bring browsing more inline with the desktop experience (Mitchell, 2006).

Mash-ups
A mash-up is a website or web application that uses content from more than one source to create a completely new service. Content used in mash-ups is typically sourced from a third party via a public interface or API (Source: Wikipedia). Interestingly, the word mash-up is derived from a method in the pop music industry whereby a song is created by fusing elements from other recordings (Merrill, 2006). Mash-ups are revolutionizing web development and will influence the way maps can published on the web, especially involving third party vendors, such as Google Earth.

GIS Data in Relational Database Management Systems (RDBMS)
Early GIS data was stored primarily in proprietary file formats. As the industry change to more open systems, the relational database management system has emerged as the preferred way to store GIS information, primarily because of the open architecture standardization, and ability to integrate with other databases.

GIS Integrated with Business Systems
GIS is increasingly being embedded into other business software, significantly reducing programming costs for spatial analysis of data. Financial, customer, property, asset, and maintenance data for example, which is generally captured in other corporate systems, is now being integrated with the GIS.

Unprecedented Access to GIS Data
GIS data availability is rapidly growing for GIS data users. In the early years of GIS, data was available in proprietary formats and not easily shared between governments and businesses. With the proliferation of personal computers, use of the Internet and standardization of GIS data formats, access to GIS data has become much easier and widespread. Many governments and private businesses post data on web sites for download and consumption, either for free or for a fee.

Emphasis on GIS 'Management'
Increasingly, the emphasis is on GIS management and the accompanying tools to analyze organizational work flow, to model the GIS data flow and analysis, and to implement systems that are fully integrated with the strategic objectives of the organization. This kind of emphasis requires a more corporate management oversight with responsibility usually in a department that is neutral and traditionally in a support role, such as an IT department.

Mobile GIS
Wireless technologies combined with the previously discussed Web-enabled GIS are allowing spatial data to be moved into the field and used in many ways, such as feature finding (e.g., utilities), field editing of data, and routing.

Broad Public Acceptance & Knowledge
Although an acronym not widely known or used, GIS has been a driving force behind much of the mainstreaming of web-based mapping found today on the internet. Web sites like Map Quest and Google Earth deliver GIS functionality, but largely without the average user knowing what GIS really is. This has been a big boost for the GIS community and has had positive side effect in that it has raised the public's awareness and acceptance of finding information via a mapping interface. And not only are map interfaces becoming more accepted for obtaining information, but collectively the public's skill level has been raised. Simple functions like pan and zoom and the ability to navigate in a map-based environment are becoming part of the collective knowledge base of users, furthering to help boost GIS as a common accepted information tool.

Architecture & Application Choices

The move to the enterprise GIS model will provide the opportunity to take a fresh look and evaluate system architecture and software applications. The City's current GIS has evolved incrementally over time without any comprehensive assessment of a system-wide architecture. With a well designed system of hardware and software, the City will be able to have the greatest flexibility, scalability, and efficiency in terms of providing sustainable GIS services into the future

While the system design will be completed in conjunction with the user requirements and needs assessment, there are some technology choices that, given the state of the

industry, are likely be deployed at the City as part of its enterprise GIS implementation. These include the following:

Suite of Software
With the enterprise model, GIS will be available to a large group of people with varying knowledge and skill levels; therefore the applications provided need to reflect the needs and abilities of the target groups. The best method for delivering the "right tool for the right job" is to have a suite of software. ESRI, the preferred GIS vendor, has a diverse range of GIS products that can work well out of the box with a wide range of users, and can be custom tailored to meet individual needs. This includes high end data maintenance, analysis, and map production as well as casual querying and look-up. ESRI is currently the City's GIS software vendor.

Web-Based Mapping
Probably the most visible side of GIS is GIS that is web-based. Web-based mapping has allowed for a significant advanced in the ability to deliver light-weight mapping functionality (thin client) to a large audience at a relatively low cost. With web-based mapping:

- User software requirements are minimal. Users only need to have a web browser.
- Networking requirements are minimal. Users only need to have a standard Internet connection to use a web application.
- Application software and settings can be maintained on a central server and published out to users, thereby eliminating the need to install, configure, and maintain application software and settings on each user's computer.

Centralized Data
Centralizing GIS data is the foundation of the enterprise GIS model and will be a critical part of the success of the City's enterprise GIS. Having the data in one location is a more efficient way to store and manage large quantities of data and streamlines management and reduces data maintenance redundancies. Users no longer have to wonder if they are using the most current version. The centralized management also allows for other enterprise GIS objectives to be administered, such as data integrity, security, accuracy, and reliability.

Geodatabase
Accompanying the centralized data model is the emergence of storing and managing GIS data a relational database management system (DBMS). While DBMS' are not new, GIS data has only recently started the migration towards being managed through a DBMS. This has been due to the complexity of geospatial data, the models used to build GIS data, and the legacy of the proprietary formats that most GIS data was built on in the last two decades. Additionally, effective integration of GIS data with other business systems requires that data be stored in a DBMS. Migration of GIS data to a geographic database (geodatabase) is one of the most common activities being conducted by municipalities both in the region and nationally.

Other Cities

During the development of the strategic plan, two nearby cities were evaluated for best practices and implementation of GIS. These cities were evaluated to see how effective a corporate GIS model is within their municipality.

Oregon City, Oregon
Oregon City has a partial enterprise GIS. They use a combination of applications to deliver GIS to city departments. Their primary internal application is a desktop application called City Works by GeoNorth. It provides basic mapping capabilities and includes functionality such as address labeling and a document query tool. The City uses GeoCortex on their public web site. They have customized the application with numerous additional tools. The GIS home page is a well designed web page with access to a variety of information including the interactive map, static maps, custom reports. It is also integrated with other business systems such as the City's permitting system.

Oregon City's approach to implementing GIS has been incremental, involving developing basic tools to improve work flow and save on staff time. They have then used these basic tools to build other applications. Other departments have observed the efficiencies made possible through these GIS tools and have help fuel interest in developing more applications. The City's GIS is located within the Community Development Department and provides GIS services to all City departments.

Oregon City, GIS Staff & Related Staff	
Position	**Number of FTEs**
GIS	
GIS Coordinator	1
GIS Analyst	1

Hillsboro, Oregon
The City of Hillsboro has a GIS program located within their Information Services Department. The GIS operates as an enterprise GIS. Multiple applications are used by the City to provide mapping capabilities to City staff, including a similar MAGIC application and an ArcMap based application (Utility Viewer). In the near future, Hillsboro will be migrating to MapOptix for their internal browser and will also use Multi-Map as a tool for publishing maps and reports on their external web site.

Hillsboro, GIS Staff & Related Staff	
Position	**Number of FTEs**
GIS	
GIS Coordinator	1
GIS Analyst	3
GIS Related	
Database Administrator	1
Systems Analyst	2

Recommended GIS Strategic Initiatives

From the preceding chapters, it can be concluded that GIS is an information asset and is a valuable tool for providing efficient government service to the community. It can also be concluded that to date the City's investment in GIS technology has been limited to department level activities, with essentially no corporate oversight and strategic direction to guide investment and improve business processes. Additionally, existing technology and processes for maintaining the City's current GIS are inefficient and outdated and generally limited in its ability to integrate with other corporate business systems.

With a strong city-wide demand to improve customer service, work flow and business processes by integrating map-based information with corporate business systems, the City is at an important crossroad with GIS technology. The City needs to develop a city-wide or enterprise GIS, and institute an organizational model that is highly efficient; A GIS that:

- Provides a more efficient and cost-effective means for managing, maintaining, and monitoring geographic data;
- Improves access to the City's geographic information, as well to other agencies through data sharing opportunities;
- Maximizes existing resources devoted to the management and maintenance of geographic data;
- Reduces repetitive and redundant maintenance of GIS related data;
- Improves reliability, quality, and performance of GIS for staff and the community
- Provides a corporate strategic direction for GIS investment and activities;
- Improves workflow in and between departments;
- Integrates with existing and planned business systems;
- Delivers GIS services to the community that reduces cost and adds value.

In order to accomplish an enterprise GIS and create a more efficient model for the City's geospatial data, the following initiatives are recommended:

- *Develop and Implement an Enterprise GIS Strategic Plan*
  A strategic plan will be the guiding framework document for establishing the initial vision, goals, objectives, requirements, and other parameters associated with implementing an enterprise GIS.

- *Conduct a Pilot Project*
  Given the magnitude of the investment for an enterprise GIS and the timeline associated with deployment of the technology, a pilot project is an excellent opportunity to early on merge the planning stages with the implementation stages of project development and provide a tangible product that will serve as a way to educate stakeholders and build support for project.

- *Establish System Architecture Hardware/Software Environment*

The foundation of an enterprise GIS is its architecture design, hardware environment and suite of software. The system architecture should reflect the needs and requirements defined in the strategic plan.

- *Develop Map Base*
  The foundation of the enterprise database is a map base and associated data models. Databases can be the most time-consuming and expensive part of an enterprise project. Development of a map base will require careful evaluation, needs assessment, and prioritization.

- *Develop Standards and Procedures*
  A GIS is more than hardware, software, and data. It must also include standards and procedures that enable the data and technology components of the system to work together efficiently. In a municipality with different departments and varying GIS requirements, standards and procedures will be critical in ensuring the system work correctly.

- *Web-based Mapping*
  The City's current application for delivering mapping capabilities to most employees is outdated and inhibits further integration. In order to ensure adequate integration with other business systems, work with a more open architecture standards based application environment, and improve mapping services to the community, a web-based mapping application is needed.

- *Priority Application Development/Integration*
  The enterprise GIS will need to have the appropriate environment to allow the system to be enhanced over time as system are replace or upgraded. This environment should be flexible and low-cost to allow ease of integration. Application development and integration capability need to be design into the system early on during the design phase. Initial application development and integration efforts should focus on priority applications.

- *Develop Training Plan*
  The City will also need to develop a training plan so that the knowledge base within the organization is maintained and users received the appropriate amount of training relative to the level of interaction they have with the system.

- *Transition to Program*
  In an enterprise environment, a GIS cannot be turn-keyed and left without leadership and coordination. Some level of program will need to be established in order to ensure continuing success and operational efficiencies.

Recommended Initial Enterprise Application Focus Areas

As part of the initial enterprise GIS deployment involving the recommended strategic initiatives, there are specific key application development areas that need to be

considered initially. These areas will help establish the critical GIS foundation, affect the largest set of business processes early on, and are likely to provide the most 'bang for the buck', as well as provide a very visible and tangible product to end users. The development areas identified below are preliminary, but provide good indication of the likely areas of focus given what is know about the current environment. The Needs Assessment will help provide more definition of the focus areas.

- *Replace MAGIC with sustainable, scalable, enterprise oriented development environment*
  MAGIC is currently the de-facto enterprise application for basic map look ups and querying within the City. It contains a substantial amount of built in custom functionality that is used routinely by City staff. Most of the functionality will need to be transferred to a new sustainable development environment, as the current ArcView 3x-Avenue based application is no longer feasible to develop. The replacement is presumed to be some type of web-based application based on ArcIMS. 'Replacement' of MAGIC GIS functionality is generally a minimum expectation. Web-based interactive mapping applications contain a substantial amount of functionality and usually with a minor degree of enhancement they can provide considerable improvement compared to the current environment.

- *Master Addressing Database/Geocoding Service*
  Addressing information is a fundamental part of GIS, as well as other business systems within the City. The current addressing business process in GIS is time-consuming to maintain, contains redundancies, is isolated from other business data, and not suitable for integration. Similar to the replacement of MAGIC, establishing a master address database and accompanying workflow redesign, so that one database is maintained, is a minimum expectation, and is an essential block in the enterprise GIS.

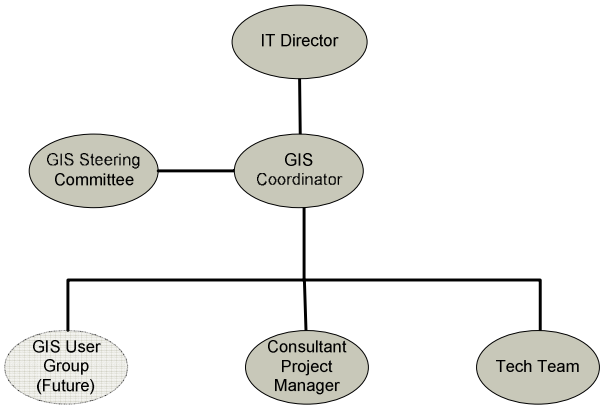
- *Public access to mapped based information*
  Accompanying the web-based mapping application will be the important additional step of providing public access to the City's GIS data. Some departments all ready provide mapped information on the public web site; however, there is potential to significantly improve this information. For example, crime data is currently not available, yet there is a steady flow of request for this information. From the Needs Assessment phase the high demand data will be identified, which can then be bundled and delivered as appropriate for public consumption. Most cities with mapped based information available to the public develop a front-end design specifically for access GIS data.

- *Utility Systems, Conversion to GIS format*
  Public Works data is partially stored in CAD and partially paper based. To be useful in terms of integrating the data with business systems, the data needs to be converted to GIS format. The effort to bring water, sanitary, and storm data into GIS will be considerable. Although the initial enterprise effort should focus on establishing the city-wide system and infrastructure, data conversion usually accounts for a fair amount of project resources. The utility systems of Public Works are a large component and are anticipated to reap the largest efficiency gains from the conversion to GIS. The Steering Committee will need to carefully

evaluate prioritization of the utility systems relative with other data layers in order to ensure maximum efficiency of limited project resources.

Project Organizational Structure

Implementation of the enterprise GIS will effect multiple departments across the organization. In order to ensure the project receives city-wide representation, that policy matters are appropriately reviewed, and that there is sufficient project management authority, a well design project organizational structure must be in place. The following diagram shows the proposed project organizational structure



IT Director
The Information Technology Director heads the Information Technology Division within the Financial and Information Services Department. The GIS Coordinator position is within the Information Technology Division and will report to the Information Technology Director on the status of the GIS project. Policy matters related to this project will be made by the Director of Financial and Information Services. The City Manager and Executive Staff will be consulted and provide input as necessary to assure a smooth and successful GIS deployment.

GIS Coordinator
This is a newly created position and is located in IT. The GIS Coordinator will be responsible for overall project management and program development of the enterprise GIS. The GIS Coordinator provides leadership, coordination, and monitoring of the day to day activities of the enterprise GIS. The GIS Coordinator will be responsible for ensuring communication and decision-making is made up and down through the established project organizational chart.

GIS Steering Committee
The GIS Steering Committee will be responsible for key project decision-making, prioritization, and policy formulation during the enterprise GIS project. The GIS steering committee will assist in the following areas:

- Oversight during implementation of the GIS strategic plan. Review of major work elements of the work plan;
- Prioritization related to limited project resources;
- Review of standards and procedures necessary to maintain an enterprise GIS;
- Levels of accuracy needed to fulfill the purpose of the system;
- How the information will be accessed within the organization, different user groups and the public.

Technical Expertise
Given the technical complexity and diverse skill sets required for an enterprise GIS implementation, professional GIS services from contracting are expected during certain portions of the enterprise GIS development process. Specific project elements requiring consulting services have yet to be determined, but will most likely occur during portions of Phases 2 thru 4. The GIS Coordinator will be responsible for project scopes of work involving consulting services and will be the main liaison with the consultant project manager regarding contract execution.

GIS User Group
The GIS User Group will be composed of regular users of GIS within the organization, primarily GIS Specialists/Analysts. This group will meet to share information, troubleshoot software and data issues, and provide professional suggestions/recommendations on GIS analysis projects of group members. This group has not been officially formed, but is anticipated to be formed once there is a sufficient critical mass of users.

Tech Team
The Tech Team will be responsible for much of the 'behind the scenes' assembly, testing, and deployment of the hardware/software environment. The Tech Team will be composed of primarily IT staff and may include occasional input from subject matter experts in other departments.

Chapter 3 Vision Goals and Objectives

Sections covered in the Chapter:

- Introduction
- Tigard Enterprise GIS Vision
- Components of Enterprise GIS
- Enterprise GIS Goals and Objectives
- Measures of Success
- GIS User Groups
- Government Partnerships

Introduction

The City of Tigard recognizes the importance and utility of technology as a means for improving its business processes, infrastructure, services, information and decision-making. As the acquisition, management, and dissemination of information continue to be increasingly valuable functions within local governments, so too has GIS proven to be increasingly valuable. The City of Tigard is no exception to this observation, as it has benefited from its initial investment in GIS. GIS and related output (e.g., maps and analysis) has contributed to improve City business processes, information exchange, and decision-making.

To that end, the City recognizes the value and importance of an enterprise GIS, and thereby proposes to take the necessary action to ensure that its implementation is efficient, effective, demonstrates value and is sustainable. Positive, yet reasonable, vision, goals, and objectives will prove to be critical as the City proceeds with its enterprise GIS implementation. The benefits of GIS, especially an optimal return on investment and improved efficiency and effectiveness, can only be realized if GIS is adopted and integrated on a city-wide basis.

Tigard Enterprise GIS Vision

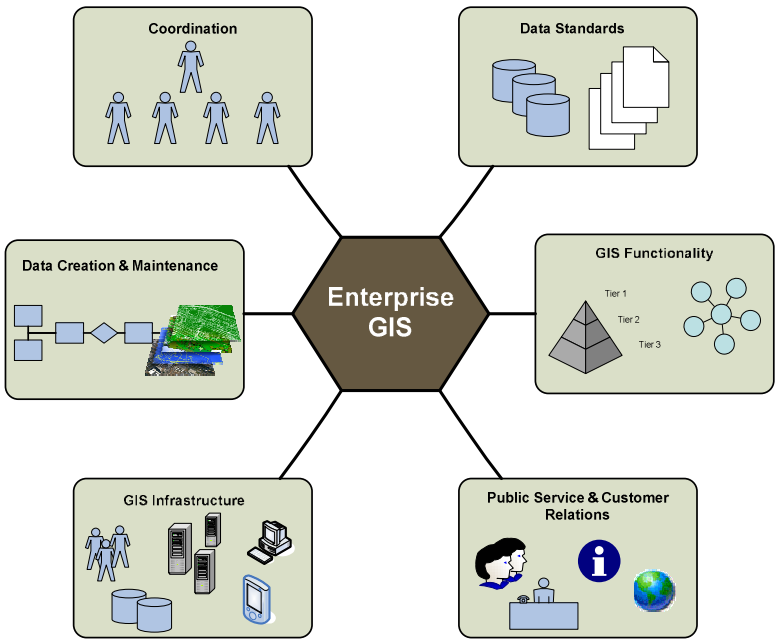
The vision is a succinct messaging articulating the ultimate goal. In the case of the vision for the City's GIS, it describes the desired state of information use and will help those involved envision the ideal end use, functionality, and end products.

The Geographic Advantage

"Provide a robust and high quality geographic information system that empowers users to efficiently manage and maintain accurate, reliable, and consistent geographic data, and to easily and quickly obtain information in various formats on demand."

Components of Enterprise GIS

The GIS vision for the City is to provide a high quality system to empower users to manage and quickly obtain geographic data on demand. It is important to realize the enterprise GIS project is not just a deployment of technology. It involves an interdependent set of components that through careful orchestration will lead to a successful enterprise system. These components include the following:



Modified graphic, credit to West Sacramento GIS Strategic Plan

Each of these components contains specific elements themselves and only through a coordinated effort will the vision be achieved. These components include:

- *Coordination*
  1. Enterprise-wide GIS management
  2. Leadership & management support
  3. Identification, development, and maintenance of knowledge skills for spatial data handling
  4. Public service needs analysis and assessment
  5. Strategic and tactical support for projects and programs

- *Data Standards/Procedures*
  1. Accurate, reliable, and consistent geospatial data standards
  2. Implementation of enterprise-wide metadata standards, procedures, and protocols
  3. Documentation, archiving, and indexing of geospatial data

- *GIS Functionality*
  1. Effective use of GIS

2. Defined tiers of GIS functionality
    a. Tier 1 GIS Administration
    b. Tier 2 GIS Analyst/Data maintenance
    c. Tier 3 GIS Viewers, browsers
3. Inter-governmental access & Public access

- *Public Service and Customer Relations*

1. Improve efficiency, productivity, and enhance public service related to information containing geospatial data
2. Expand and improve public access to GIS

- *GIS Infrastructure*

1. Technology: hardware/software/infrastructure
2. People: Skilled personnel, knowledge base
3. Data: geospatial information

- *Data Creation, Conversion, Maintenance*

1. Geographic data handling procedures to acquire, process, store, and distribute GIS data
2. Conversion, integration, and standardization of disparate data from multiple sources and applications

Enterprise GIS Goals & Objectives

The vision and statement provides the broad inspiring statement and initial direction for Tigard's enterprise GIS. To make the vision tangible, achievable, and enduring, there needs to be concrete goals and objectives to guide short term decision-making and actions. In addition, measures of success will let us know if we've met our goals. These goals and objectives are intended to be achieved by the end of the GIS Strategic Plan time line, or within three years. At this time a revaluation will occur to verify if the goals and objectives have been met. The following goals, objectives, and measures of success stem from the vision and will help guide the City towards a successful development and deployment of the enterprise GIS.

Goal 1: GIS Quality

Accurate, consistent, and complete core geographic database

Objectives

1.1: Establish a **centrally managed geographic database** usable by multiple departments.

1.2: Establish and implement a **system design** for enterprise GIS architecture.

1.3: Establish **standards and procedures** for the development and maintenance of geospatial data.

1.4: Establish **standardized methods** and procedures for application development related to integration with GIS (build it once, use it over and over again).

Measures of Success

1.1. GIS data can be accessed centrally by multiple departments with relative ease via common point of entry.

1.2. System architecture as designed in place and operational.

1.3. Completed migration of enterprise GIS data from a file based data structure and file-sharing environment to a spatially enabled, relational database management system.

1.4. Standards and procedures in place for on-going management of data, workflow, methodologies, and resources.

1.5. Regularly scheduled and automated workflow, to the extent practical, of GIS data updates for key base map layers from source system to the repository.

Goal 2: Ease of Access

Easy and common access to geographic information

Objectives

*2.*1: Establish an efficient, reliable, and sustainable **organization-wide access** to geospatial data.

2.2: Promote and guide the implementation of **web based applications** that facilitate access to geographic information.

2.3: With GIS technology, **improve public access to online city services**.

Measures of Success

2.1. Improved performance and access to enterprise data for departments from previous methods of access.

2.2. Initial enterprise deployment composed of web-based mapping solutions for GIS.

2.3. City GIS web-site updated with improved access to City services involving map-based information.

Goal 3: Integrated GIS

Integration of GIS with other core business processes

Objectives

3.1: Promote the integration of **GIS with other business systems and programs**.

3.2: Use **standardized technologies and techniques** in order to ensure more seamless technology integration.

Measures of Success

3.1. Successful integration of enterprise GIS with identified core business processes.

3.2. Standardized methodologies and techniques in place and in use during design and development of integrating GIS with other business systems.

Goal 4: GIS Training

GIS knowledge base improved within the organization

Objectives

4.1: Facilitate a **GIS clearinghouse for sharing ideas**, discussions, and information about GIS related topics.

4.2: Improve GIS **training opportunities** to staff to empower them to fully utilize GIs functionality.

4.3: Establish a GIS **user group network** within the organization to help facilitate and grow the institutional knowledge base.

Measures of Success

4.1. In place technical support of enterprise GIS resources.

4.2. In place GIS training program.

4.3. GIS User Group established and functional.

4.4. GIS web site established as centralized "one-stop shopping" information center for all GIS related resources (e.g., standards, procedures, data dictionary, and policies).

Goal 5: GIS Sustainability

Cost-effective and sustainable use of GIS technology throughout the organization.

Objectives

5.1: Establish **centralized review and coordination** of GIS resources, infrastructure and initiatives.

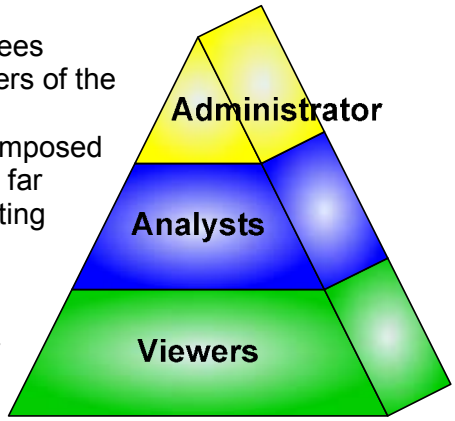
5.2: Develop an **on-going GIS program** to ensure efficient use of enterprise GIS resources.

Measures of Success

5.1. GIS Program established with program goals, objectives, and work plan.

5.2. GIS Program oversight established to ensure on-going system effectiveness.

GIS User Groups



Enterprise GIS will be accessible to all City of Tigard employees and eventually the public via the City's website. Different users of the enterprise GIS will have different requirements that can be characterized in this pyramid model showing a set of tiers composed of Viewers, Analysts and Administrator. The Viewers will by far represent the largest user base of the enterprise GIS, consisting of primarily web-based mapping use. The Analysts user group represents the 'power' set of users that have more advanced requirements for GIS and therefore need the toolsets at their disposal. The Analysts will likely be the user group equipped with desktop applications of GIS.
The Administrator user group is essentially the system level management of enterprise GIS. This model is not meant to be a rigid concept, with either or implications, but instead serves as general hierarchy for understanding how users will interact with the system and what their relative needs will be. The chart below identifies some of the specific user group activities.

GIS User Group Activities	
Group	**Activity**
Administrator	• System Administration • Data input/maintenance of the enterprise database • Data conversion • Spatial data management housekeeping • Technical support • Coordination of corporate GIS activities
Analysts	• Data Maintenance • Analytical functions/Geoprocessing • Complex queries • Modeling • Use of desktop extensions • High quality map production
Viewers	• Browsing/Look-up • Standard reports • Simple query • Read-only access • Simple map production

Government Partnerships

Government partnerships are an important part of a municipalities' GIS program. Data is expensive to develop and maintain, and knowledge sharing is essential in providing

efficient public services. Tigard is fortunate in that many Portland metro area governments have invested significantly in GIS technology over the last two decades and have created robust GIS databases and programs. Many of the data sets are available through subscriptions and partnerships. Tigard currently subscribes to Metro's RLIS-Lite and is part of the regional orthophoto consortium. As well, Tigard participates in data sharing with Washington County. As Tigard moves into an enterprise GIS environment, its ability to share and received data can improve. With an established GIS program, Tigard will also be able to coordinate more efficiently in data and knowledge sharing with other established GIS programs in the region, including larger programs such as the State's evolving 'GIS Utility' program.

Chapter 4 Organizational Structure & Staffing

Sections covered in this chapter:

- Introduction
- Organizational Structure
- Enterprise GIS Staffing Evaluation
- GIS Positions/Roles –Described
- GIS Groups -Described

Introduction

As emphasized throughout this plan, GIS is more than the technology. It is equally about skilled and knowledgeable people developing, administering, and maintaining the system. Of critical importance to the success of the City's enterprise GIS will be how it is structured within the organization and the proper allocation of staff resources. This chapter discusses the organizational structure of GIS within the organization, meaning its location within City's department organizational structure, necessary staffing requirements for a municipality the size of Tigard, including recommendations, and a discussion of the various roles of support staff associated with maintaining the enterprise GIS.

Organizational Structure

Essentially, organizational models for GIS fall into either centralized or decentralized, or some hybrid of the two. The City's current model is decentralized, with departments assuming responsibility for management of their own GIS resources and data management.

The general trend for organizations, especially governments, is to move towards the centralized model of GIS management, with IT departments assuming responsibility for program management. The fit is logical. Information systems, databases, and networks are inherent to IT departments (ArcNews, 2004). Also, GIS has become complex in recent years, especially at the enterprise level, and requires more technical expertise related to system administration/planning, business analysis, coordination, application development, and software applications. These are traditionally IT functions. In addition, management lead from IT department is a logical migration because IT departments are usually in a 'corporate' support role operating as a neutral department in the implementation of corporate-wide activities.

The City will locate GIS administration within Information Technology Division of the Financial and Information Services Department. This was decided early on in the

planning stages of the City's enterprise GIS and was made after consulting other local jurisdictions within Washington County and researching trends in the industry. The move is also consistent with the IT Division's mission of providing cost-effective access to data in a centralized computing environment.

The location of GIS within IT does not mean all GIS activities will occur within IT. There is also a need for certain departments to use trained staff to provide in-depth GIS analysis where there is a need. The City currently has several positions located within specific departments (see matrix below) performing GIS specialist related activities. These department GIS specialists provide a valuable support service to their departments by being physically located within the department, employing their GIS skills, and also having in-depth knowledge in the specific areas or disciplines, such as planning or crime analysis.

While the location of department GIS specialist is good for the specific department, it can mean problems for other departments in need of occasional GIS analysis. As will be discussed below, some additional GIS expertise is needed at the enterprise level to provide additional analysis and GIS services.

Enterprise GIS Staffing Evaluation

Having the "right" resources on-board is a critical factor in an enterprise GIS. Especially important is having a core set of resources during the ramp-up or learning curve of applying GIS technology to everyday activities. This section evaluates staffing requirements and recommendations related to the enterprise GIS. These recommendations focus specifically on the first three years of the start up period of the GIS Program.

GIS Functional Areas and Staffing

A variety of positions interact in the administration of an enterprise GIS. Some are devoted resources, such as the GIS Coordinator and others are ancillary or support positions. Shown below is an enterprise GIS Resource Matrix to assist in identifying the resources required for implementation and operation of the enterprise GIS, as well as to making the business decisions of how to best provide the required support. The matrix is based on a relatively small scale organization where an enterprise GIS is implemented and coordinated centrally within an IT department.

In the first column are functional categories that are needed to minimally operate and support an enterprise GIS. The position titles for each of the columns in the matrix are typical titles for GIS support positions. This matrix shows how the functional categories are typically distributed and/or shared, or possibly outsourced.

GIS RESOURCE MATRIX						
FUNCTIONAL CATEGORY	**GIS COORD**	**GIS ANALYST**	**DEPART GIS SPEC**	**DATABASE ADMIN**	**WEB ADMIN**	**HELP DESK**
Sys Admin (hw/sw)	C					
Database Admin	C			C		
Data Integration	C	C		C		
Data Maintenance			X			
Data Conversion	C	C	X			
GIS Business Process Evaluation	C	C				
Routine App Dev	C	C				
High End App Dev		O				
GIS Analysis		C	X			
Web enabled GIS	C	C			C	
Routine Daily use			X			
Answer Questions/front-end troubleshoot	C					C
System Monitoring	C					
GIS Project Management	C					
Data Acquisition	C		X			

Key	
C	Centralized in IT
O	Most likely outsourced
X	Decentralized in departments
Grayed	Resource currently not available at City

Most of the functional areas are concentrated in the GIS Coordinator and GIS Analyst positions. In the centralized GIS model, system administration, GIS project management, application maintenance and development, and other associated functions are performed by a few dedicated staff with specialized skill in order to support widespread use by non-technical users. The functional areas identified in the matrix are varied and typically require different positions. The GIS Coordinator focuses more on system administration and program development whereas the GIS Analyst performs application development and higher end GIS analysis. In a small organization, these functions may be bundled into one position, but as a GIS evolves and grows within an

organization, these functions are generally split into their respective job functions. This allows the GIS Analyst to focus on providing GIS services directly to departments, in particular those without GIS skills, and developing GIS tools and applications for a broad base of users across a broad spectrum of business systems. Since use of the City's GIS is expected to grow once the initial implementation is complete, both of these positions will be extremely important in providing the appropriate level of expertise and support to City departments.

Current GIS Staffing

The matrix below shows the current distribution of GIS staff. There is currently one position assigned full time to GIS support, the GIS Coordinator. The other positions fall under different job categories and perform GIS duties as part of their job description. Assigned GIS duties range from one quarter time (10 hours per week) to half time (20 hours per week). These duties involve data maintenance, GIS analysis, and map production.

CURRENT DISTRIBUTION OF GIS RESOURCES	
DEPARTMENT	**PORTION OF POSITION ASSIGNED TO GIS MAINTENANCE/SUPPORT/ANALYSIS**
Financial & Information Services Department	
• GIS Coordinator	100%
Community Development	
• Associate Planner	50%
Engineering	
• Engineering Tech	25%
Police	
• Crime Analyst	25%
Public Works	
• GIS Tech (1)	100%

(1) Position budgeted, but not filled

Recommendations

As shown between the two matrixes above, there is a gap in the current level of GIS support and the desired level of support for an organization implementing an enterprise GIS. The current environment has only one devoted GIS support position (GIS Coordinator), with several other positions embedded within the departments performing GIS duties to support department demand. Based on this evaluation, additional staffing will be needed to provide adequate support for the enterprise GIS. A GIS Analyst position located in the IT Division is recommended in order to provide enterprise GIS support and fill in the identified functional areas as indicated above. Database Administration, while identified as a needed functional role necessary to support GIS, will need to be further evaluated from an overall city-wide information systems support perspective. The table below shows the proposed distribution and addition of GIS staff and related support. It is recommended that departments continue to monitor and gauge the level of GIS work assigned to their GIS Specialist and coordinate significant changes with the GIS Coordinator.

PROPOSED DISTRIBUTION/ADDITION OF GIS RESOURCES AND RELATED SUPPORT				
DEPARTMENT	**FY 06/07**	**FY 07/08**	**FY 08/09**	**FY 09/10**
Financial & Information Services Department				
• GIS Coordinator				
• Web Administration(1)				
• GIS Analyst				
• Database Administration (1)				
Engineering				
• Department GIS Specialist (2)				
Community Development				
• Department GIS Specialist (2)				
Police				
• Department GIS Specialist (2)				
Public Works				
• Department GIS Technician (2)				

Existing Position
Proposed Position
1) Contractual
2) Job title varies in each department. Level of GIS work subject to individual department work programs.

GIS Positions/Roles -Described

GIS Coordinator
The GIS Coordinator is responsible for overall coordination of the City's GIS Program. Specific day to day responsibilities of this GIS Coordinator include: program management, system administration, GIS database administration, back-up and recovery, application maintenance, hardware/software upgrades, and oversight of help desk activities (involving technical GIS issues). The GIS Coordinator is also responsible for project management of GIS projects or is the primary contact on major projects including a GIS component. Additionally, the GIS Coordinator is responsible for program assurance. This includes:

- Developing overall strategy
- Quality management assurance
- GIS budget and resources
- GIS Program communication

- Developing the business case
- GIS documentation
- Consultation within the organization

GIS Analyst
The GIS Analyst acts as a major participant in the development and implementation of GIS analysis projects and application development. GIS Analyst are usually skilled in multiple statistical techniques, programming languages, relational databases and are able to develop and interpret functional requirements in the development of GIS related business process improvement and integration. GIS Analyst usually have received some formal training and often have degrees or a high level of experience in GIS. There are various professional levels of GIS Analyst (e.g., I thru IV).

The recommended GIS Analyst position would be located within the IT Division of the Financial and Information Services Department and report to the GIS Coordinator. By being located within IT, the Analyst position can remain 'department neutral' and take on projects and duties with an enterprise service role serving a broad base of users. The position would provide GIS Analysis services to all City departments as established through the GIS work program and directed by the GIS Coordinator.

GIS Specialist –Department Specific
A GIS Specialist is involved with development and implementation of GIS analysis projects. GIS Specialists are usually skilled in research techniques, multiple statistical techniques, locational and spatial analysis techniques, and knowledgeable in different types of GIS software. GIS Specialists are also involved with the development and maintenance of geographic data sets. GIS Specialists often have an accompanying specialty knowledge associated with their GIS skills (e.g., environmental, forestry, transportation, planning, and crime).

As noted in the above matrix, some of the current GIS Specialist positions are not full time. Additionally, some do not carry the title of GIS Specialist, but perform GIS duties as part of their job description. While GIS Specialists perform work primarily for requests within their department, they also, depending on workload, perform ad-hoc analysis and GIS related functions for other departments. The level of time devoted to GIS is subject to the discretion of each department's need for GIS work.

GIS Data Custodians
The Data Custodian is not a position, but is a role assumed by specific staff members related to establishing ownership, accountability, and maintenance of GIS data. In a multi-participant GIS, it is important to institute formal responsibilities for the creation and maintenance of GIS datasets that are part of the enterprise GIS. The Data Custodians are essentially the data owners and are the responsible person(s) for establishing levels of accuracy, currency, maintenance schedule, access limitations, and overall level of use related data layers. GIS Data Custodians do not have to be the individual maintaining the data, but can delegate that responsibility to another person. The GIS Data Custodian is the primary contact in regards to major decisions related to the specific dataset.

GIS Groups -Described

This section describes committees and groups associated with and responsible for elements of the GIS Program.

GIS Steering Committee
As mentioned earlier, the GIS Steering Committee is responsible for key project decision-making, prioritization, and policy formulation during the enterprise GIS project. Once the initial enterprise project is complete, a GIS Steering Committee will need to continue to provide review and feedback of major GIS program changes, changes to standards and procedures, and other GIS program initiatives potentially impacting departments. Essentially, the GIS Steering Committee, or its replacement committee, will change from a project implementation oversight mode to a program management oversight mode. Once the GIS project is complete, the Steering Committee will need to evaluate its role and develop a new charter and set of operating principles for its continuance.

GIS User Group
The GIS User Group serves as an internal support group for staff actively involved in GIS. The term “user” in this context refers to those involved with advanced GIS analysis and mapping activities, using primarily desktop applications.

Generally GIS Users are involved with:

- Ad hoc query, manipulation, analysis, and display of spatial data
- Map production
- Basic spatial queries using common GIS tools
- Basic tabular queries of data
- Editing of data

In addition to their analytical skills they provide, GIS Users help fulfill a valuable role in their “front-line offense” of Tigard GIS. GIS Users are located in different departments and thus have detailed knowledge of both the data they use and their business processes. To help convey the knowledge and importance of enterprise GIS principles with their specific departments, GIS Users are obligated to:

- Be a steward of City GIS standards and procedures
- Use GIS data in a professional and responsible manner
- Be the department or area “go-to” person for general GIS questions
- Attend and participate in the Tigard GIS User Group

Chapter 5 Cost Benefit Analysis

Section covered in the chapter:

- Introduction
- Overview GIS Cost & Benefits
- Literature Review
- GIS Benefits –Overview
- Measuring Benefits
- Quantitative Benefit –City of Tigard
- GIS Quantitative Benefit Analysis
- Efficiency Effectiveness Evaluation

Introduction

Investments in GIS technology are often accompanied by questions about the benefits of the investment. What are the benefits? Will the system pay for itself? Or can we afford not to do this? One of the primary selling points of a GIS implementation are the improvements in efficiency of existing operations, as well as improved efficiency at performing new tasks; however capturing these in quantitative form and comparing them to costs is not an easy task. Without a very thorough and in-depth analysis, it's possible to overestimate, or underestimate the true benefit the investment brings to the organization. It is usually necessary to present a combination of *qualitative* measures and narrative along with *quantitative* measurement to provide a complete picture of the cost and benefits of a GIS implementation. This chapter provides an overview of the cost-benefit analysis, a literature review of how cost-benefit analysis is being applied in other organizations, a narrative of the 'intangible' benefits of GIS, and a benefit analysis based on the anticipated efficiency and effectiveness potential for the organization.

Overview of GIS Cost-Benefit Analysis

Understanding the cost-benefit, or value, GIS brings to the organization is an important part of the strategic planning process. A common analysis tool for assessing the costs and benefits associated with an investment is a cost-benefit analysis. The cost-benefit analysis is a systematic approach to account for all of the costs of an investment and compare them to all of the benefits that can also be calculated. The result is usually a benefit to cost ratio, meaning a fraction representing the return (benefit) on the investment (cost). In short, a ratio showing if the investment will pay for itself. The advantage of the cost-benefit analysis is that it helps take the opinions and emotions out of the evaluation and attempts to account for, to the extent possible, the monetary costs and benefits associated with the investment (Wilcox, 1990).

While it is relatively easy to explain and articulate the costs and benefits of GIS by sourcing them by narrative, providing detailed measurement of <u>all</u> associated costs and

benefits of a GIS, especially an enterprise GIS is quite difficult and complex. For example, benefits can be tangible (quantifiable), intangible (non-quantifiable), and also contain external benefits (also non-quantifiable). It is also difficult to assign a value to a benefit that will occur in the future that is currently not known, but will occur once the technology is in place and its potential realized (latent benefits). In addition, the nature and magnitude of benefits and costs vary from organization to organization. Furthermore, it is often very time-consuming and expensive to develop a detailed GIS cost-benefit analysis.

Literature Review –GIS Cost-Benefit Analysis

Fortunately, in the last 10-15 years, interest in documenting cost and benefit associated with GIS has increased providing a surge in literature on the subject. Prior to that it was difficult to obtain much information on GIS and cost benefit analysis. This section includes a review of some of the recent literature related to GIS implementation and justification.

One particularly noteworthy study on the subject of GIS cost-benefit analysis is the *Joint Nordic Project Report*. The report presents information on costs, benefits, and applications of 16 well established GIS projects in North America and two in Italy. The study is considered to be one of the best single references for benefit-cost ratio data (Korte 1996). The project findings are:

- If a system is used for only computer-aided mapping and updating, it gives a full return on investment (Benefit to Cost, or B/C of 1:1)
- If the system is used for planning and engineering purposes, the investment will be double (B/C 2:1). The ratio would rise to 4:1 where all commonly used data sets have been automated.
- Research reports published in Norway and Sweden show that the B/C ratio for automating conventional maps is greater than 3:1.
- If common system is created in which information can be shared among different relevant organizations, the investment will come back four times (B/C 4:1)
- For organizations with a poor system for manual map production, the automated system has given B/C ratios up to 7:1 (Korte, 1996)

In *A Pragmatic Approach to the Cost-Benefit Analysis of GIS*, Wilcox (1990) points out that over a six year planning horizon, there is common pattern of costs and benefits. “In the first years costs are high, and benefits are low. In the latter years, benefits often greatly surpass costs. Thus it is necessary to look at the cumulative effect of the costs and benefits over time.” Wilcox also points out that “a well-planned, carefully implemented GIS can achieve a long-term, fully discounted, cumulative return about 2.5:1 over the foreseeable planning horizon.” In other words, for every dollar invested in software, hardware, system implementation and on-going operation, an organization can expect to reap $2.50 in benefit. Wilcox further points out however, that this number can vary from organization to organization and that recent cases return between 1:1 to 6.6:1.

Gillespie (1994 and 1997) conducted case studies of 62 federal governmental GIS installations and developed a regression model for estimating the benefits of GIS implementation. Gillespie identifies two classes of GIS benefits: those associated with *efficiency* increases and those involving increasing *effectiveness*. Efficiency benefits arise when GIS is used to reduce costs of a task that, in the absence of GIS, would be handled by some other method. Effectiveness benefits arise when GIS is used to perform a task that could not or would not be done without GIS. Gillespie notes that "Effectiveness benefits depend on the value of the unique GIS output" and as a result he indicates that traditional benefit-cost analysis tends to underestimate the value of GIS. The Gillespie model predicted benefit to cost ratios ranging between 1.2 and 6.5 for case studies producing *effectiveness* benefits. Furthermore, Gillespie states there is a 75% variable cost savings when using a GIS over manual methods.

Warrol (1994) identifies the 'GIS paradox': "while many perceive, financially, that they cannot afford GIS, they realize that strategically and operationally they cannot afford to not acquire GIS." Such a finding leaves agencies in a quandary; the most important benefits of GIS implementations are those most difficult to quantify, and the inability to quantify such benefits may result in a reluctance to make the kinds of investments needed to achieve the key benefits attributable to such investments allowing agencies to become more effective.

As observed by Hardwick and Fox (1999) in their review of the Warrol 'GIS paradox' "one alternative for moving out of such a quandary, lies in a mixed analytical approach to determining the benefits and costs of GIS implementation. Such an approach could focus on providing a quantitative estimate of the more straightforward efficiency benefits of GIS implementation, while providing a more qualitative estimate of the effective benefits. Using such an approach would allow for the capture of the wide range of benefits that GIS implementation can generate for an organization, while recognizing the well-documented difficulties inherent in effectiveness benefit quantification. Realizing the benefits of GIS implementation requires the successful implementation of GIS technology."

Summary

In summary, the following key points can be stated about the above literature review of GIS cost-benefit analysis:

- A comprehensive cost-benefit analysis is a difficult and complex endeavor
- While in the short run, costs are high and benefits are low, in the long run benefits often greatly surpass costs; therefore, it is necessary to look at the cumulative effect of the costs and benefits over time.
- A well-planned, carefully implemented GIS may achieve a cumulative return of about 2.5:1 over a foreseeable planning horizon, although this number is highly variable.
- The greatest benefits of GIS technology appear to come from its ability to enable agencies to provide services and do things they either could not or would not do without GIS. These are benefits that are not easily captured in traditional cost-benefit studies, which may tend to slow the adoption of GIS or lead to the underinvestment in the technology due to a lack of demonstrating a rigid quantitative return on investment.

- Evaluating the cost benefit of GIS should involve a mixed analytical approach, i.e., an evaluation of the quantitative estimate of the straightforward efficiency benefits and a qualitative estimate of the effective benefits.

GIS Benefits -Overview

The benefits of GIS have been extensively discussed in the literature, as well as extolled in the business environment to promote its value to organizations. The list of benefits is considerable. Most, however, can be isolated into some key basic categories. These include:

Increased Efficiency/Productivity

- Improvement in the delivery of a service or product
- Eliminating or reducing redundant or outdated steps in an old process
- Faster work, more units produced
- New and innovative procedures
- New or improved analytical capabilities
- Decision support

Cost Avoidance

- Lowering costs of a business process or operation (e.g., locating utilities)
- Automating workflow (e.g., paper based to electronic)
- Improving decision-making
- Fewer mistakes

Improved Access to Information

- Time-savings
- Informed users
- Increased communication

Measuring Benefits

The above section identified key categories of GIS benefits. When it comes to measurement, benefits may be divided into two categories: Quantifiable and Nonquantifable (or qualitative). Quantitative benefits are those that are measurable, usually in terms of dollar value and/or time saved. Nonquantifiable benefits cannot be directly measured but are best expressed by qualitative measures.

Nonquantifiable (Qualitative) Benefits

Not all benefits can be quantified in strict financial terms for return on investment. This is true for qualitative benefits. These more-difficult-to-quantify benefits should, however, not be discounted in terms of their contribution. Qualitative benefits can have a significant positive impact on the success of an organization's GIS investment. For

example, in many instances, GIS creates an opportunity to improve access and reliability of geographic information not possible without the GIS technology and, consequently, not comparable with any of the organization's pre-GIS operations. Generally, these new capabilities are hard to express in financial terms and can be considered intangible benefits. Interestingly, these new capabilities are frequently considered as the strongest arguments for having a GIS (Stutheit, 1990). Some common examples of qualitative benefits that can be expected from GIS include (Source: Silva 1998):

- Improved services to customers
- New analytical procedures
- Enhanced visualization of graphical data
- Improved data security
- More consistent access to data
- The ability to integrate data
- The ability to generate new 'understandings', and easier access to data
- More rigorous data management
- Reducing the potential for maladministration and liability

Qualitative GIS Benefits -City of Tigard

So what are the qualitative benefits of a GIS for the City of Tigard? One technique to assess qualitative benefits is the Value Measuring Methodology (VMM). The VMM is a cost-benefit analysis tool designed to capture the dimensions that are hard to quantify in traditional financial return-on-investment analysis. The Value Measure Methodology was originally developed by Booz Allen Hamilton and academics affiliated with Harvard University's Kennedy School of Government Security Administration and the General Services Administration.

The Value Measuring Methodology used in this analysis is one that was created for the State of Oregon's GIS Utility business case. It has been tailored to fit with the City's particular business environment. The accompanying matrix (see below) categorizes different intangible benefits for different City departments and provides a ranking method to show relative importance.

The methodology involves assigning an ordinal measurement (a ranking of High, Medium, and Low) to the various value categories. The value categories used here are derived from the State GIS business case study. Not all the State's categories from the study have been applied as they were not all relevant for the City's use. This ranking was completed with input from the GIS Steering Committee. While the assessment is subjective in nature, it nonetheless in sum provides a valuable picture of the various intangible benefits for the organization.

Results

As shown in below, several of the categories of qualitative benefits routinely ranked as high benefit. High benefit areas for all departments were data quality, accessibility, timeliness, depth and breadth, and information integrity and security. Each of these are intrinsically non-qualitative values, but nonetheless are extremely important for an organization. For example, all departments rank accessibility as high. Accessibility to GIS data, especially in an enterprise GIS is one of its top selling points. Routinely,

departments want to be able to access data but are often confronted with not knowing where to look for the data, or if it is available much work is necessary in order to make it meaningful. It is interesting to note that the benefit categories ranked high by most departments are ones that can be addressed most effectively by implementation of an enterprise program with central coordination and oversight.

Value Measuring Methodology –Intangible GIS Benefits

Value Categories	Departments/Groups									
	Eng. Services	Public Works	Com Dev	Police	Library	Admin	IT	Finance	Public	Other Gov'ts
	H High Benefit			M Medium Benefit			L Low Benefit			
Data Quality –GIS provides sufficiently accurate data and information for users and provides known measures of accuracy, currency, and completeness.	H	H	H	H	H	H	H	L	H	H
Accessibility –Spatial data is easily accessible to city staff and public.	H	H	H	H	H	H	H	L	H	H
Timeliness –Information is available when it is needed.	H	H	H	H	M	H	H	L	H	H
Depth and Breadth –Full range of data layers and tool sets available for use when they are needed.	H	H	H	H	L	H	H	L	H	H
Asset Protection –Support for assessment of critical infrastructure elements, level of risk, and effective means for risk management.	H	M	M	H	L	H	M	L	H	H
Public Safety –System provides timely and accurate information for law enforcement, emergency medical response,	H	H	M	H	L	H	M	L	H	H

Value Measuring Methodology –Intangible GIS Benefits										
Value Categories	**Departments/Groups**									
	Eng. Services	**Public Works**	**Com Dev**	**Police**	**Library**	**Admin**	**IT**	**Finance**	**Public**	**Other Gov'ts**
and fire incident, planning and response; emergency planning, event management, and disaster mitigation.										
Natural Resource Management –Provides information to support planning and management of natural resources in a sustainable manner.	M	L	H	L	L	H	L	L	H	H
Information Integrity and Security –Provides data that conforms to established standards for liability, privacy, confidentiality, security, and business continuity. Information assets are protected from catastrophe loss or corruption.	H	H	H	H	H	H	H	L	H	H
Intergovernmental Interoperability – Information-sharing and integration among disparate systems and entities within government is easily accomplished. State-Regional-Local partnerships are encouraged.	H	M	H	H	L	M	M	L	M	H
Latent Benefit Opportunity –Provides foundation/impetus for creative problem-solving analysis	H	M	H	H	H	M	M	L	M	M

Value Measuring Methodology –Intangible GIS Benefits										
Value Categories	**Departments/Groups**									
	Eng. Services	**Public Works**	**Com Dev**	**Police**	**Library**	**Admin**	**IT**	**Finance**	**Public**	**Other Gov'ts**
capabilities.										
Improving Organizational Image –GIS supports City's image as responsible and dependable municipality managing its assets and providing information to public.	H	M	H	H	H	H	M	L	M	M
Improved Decision-making –More comprehensive information base available for problem-solving, especially at key decision-making levels.	H	H	H	H	H	H	M	L	M	M

Quantitative Benefits -City of Tigard

Implementation of an enterprise GIS will also result in quantitative or measurable benefits for the City. As discussed above, these benefits usually result from improved efficiency and effectiveness and equate to labor savings. For example, the enterprise GIS will provide the opportunity to speed up data maintenance. Staff will also spend less time obtaining information and performing certain tasks. In addition, in some instances staff that normally had to ask someone else for information, can now access that same information themselves.

The enterprise GIS implementation will also allow the opportunity to clean up current redundant business process using GIS data, such as the maintenance of address information for example. In this instance, a business process will result in a reduction in staff maintenance time. The accumulation of these benefits eventually adds up and provides a measurable return on investment. Typically, the benefits of a GIS implementation start to outweigh the costs within a three to five year period (Spotsylvania, 2006). The total benefits of a GIS are only fully realized over time. Over a ten-year period the cost-benefit ratio is 1: 2.5. In other words, for every dollar spent on implementation, the benefit to the organization over time is two and a half dollars (Tomlinson, 2000). The cost and benefit relationship is depicted graphically in the chart below.

GIS Quantitative Benefit Analysis

In order to make an assessment of the potential quantitative benefits and demonstrate a return on investment of the enterprise GIS, the City conducted an Efficiency-Effectiveness Evaluation. An Efficiency-Effectiveness Evaluation involves looking at the current conditions of various business processes involving a geographic component and attempts to determine the level of benefit that can be expected if GIS is implemented. The following discusses the methodology and findings of this analysis.

Methodology

Identify Business Process Candidates
Each of the business processes involving a geographic component were inventoried and assembled in a matrix. This is the same matrix listing business processes involved with geographic information used earlier in Chapter 2. Business processes involving geographic information are any business processes that deal with location-based information. For example, the Community Development issues planning and building permits. These permits have a location (such as an address). Likewise, the Public Works Department's facilities (e.g., water system) are location based, located through the City of Tigard. As expected, a majority of the City's business process can be tied to some geographic component.

Evaluate Business Process Pre-Enterprise GIS Problem Areas

Each business process is evaluated for its pre-enterprise GIS problem areas. A list of nine categories (see below) classifies different types of problem areas (such as redundant data sets, or cannot find correct data when needed). Each business process can include more than one of the nine categories if it applies.

1. Cannot find correct data when needed
2. Maps and data are out of date, incomplete, inaccurate, or nonexistent
3. Different data sets and maps have incompatible formats, definitions, and scale
4. Redundant data and maps maintained/produced.
5. Number of maps produced is limited by the person-time required
6. Number of alternatives evaluated during a study is limited due to the time and cost required for materials and staff
7. Combining data and maps for a study is time-consuming and difficult
8. Dependent on personal knowledge and memory
9. Products are not standardized

Identify Potential Benefit Areas
Each business process is then evaluated for its potential benefits areas. These include:

a) Improved efficiency in business process/existing operations
b) Additional capabilities not available in a pre-enterprise-GIS environment
c) Improved response to unexpected, non-planned, or emergency situations
d) Revenues generated through sale of data and products

Similar to above, a business process can be associated to more than one benefit area.

Efficiency-Effectiveness Potential
With the GIS problem areas and benefit areas inventoried, the efficiency and effectiveness potential are then ranked. Efficiency and effectiveness are evaluated separately because they have different benefit implications. The following explains the difference between the two:

Efficiency Benefits
Efficiency benefits arise when GIS is used to reduce the costs of a task that, in absence of a GIS, would be handled by some other method. Example: Public Works relies on paper-based drawings/maps for daily work involving the water system. In the enterprise GIS effort, if the water system data is converted to GIS, there will be an efficiency gain in daily work involving water system data.

Effectiveness Benefits
Effectiveness benefits arise when GIS is used to perform a task that could not or would not be done without a GIS (Gillespie, 1994). Example: Police Department (PD) staff is limited in being able to quickly access crime data run quick reports. With an enterprise GIS, PD staff will have improved access to report information they previously did not have.

The ranking is based on ordinal measurement values of High, Medium, and Low using the following guidelines:

High = High potential return on investment to most all departments; Significant potential streamlining of business process as a result of enterprise GIS; Improved efficiency in response to, or business processes related to, emergency situations.

Medium = Moderate potential return on investment to more than one department; Moderate potential to improve business process as a result of enterprise GIS; Efficiency benefit potential to other agency.

Low = Return on investment potential limited to generally one department; Minor potential to improve business process as a result of enterprise GIS.

Findings

Results of the Efficiency-Effectiveness Evaluation are shown below. Overall, the majority (65%) of the business processes evaluated received a High efficiency benefit ranking. The number of Medium ranking business processes was also considerable (27%). Only 8% of the business processes evaluated had a Low potential for efficiency-effectiveness benefit.

Efficiency Effectiveness Evaluation Matrix

GIS Return on Investment Analysis: Efficiency & Effectiveness Evaluation					
Business Processes	**GIS Problem Areas**	**GIS Benefit Areas**	**Efficiency Potential**	**Effectiveness Potential**	**Comments**
Infrastructure					
Address System	1, 2, 3, 4, 7, 9	a, b, c	High	High	Data currently maintained in multiple systems. GIS will help reduce redundant databases and facilitate access of a common standardized address database.
Critical Private Utility Inventory, and agency utilities	1, 2, 3, 4, 5, 6, 7, 8, 9	a, b, c,	High	High	High potential for saving lives and property during emergency situations involving critical private utilities.
Drawing/Document Mgmt.	1, 2, 3, 5, 6, 7, 8, 9	a, b, c	High	High	High potential to access drawings via GIS interface to assist numerous business processes (especially critical during emergency response).
Facilities Mgmt.	1, 2, 3, 4, 5, 6, 7, 8, 9	a, b, c,	High	High	Current business processes involves using disparate databases, systems, and maps. Using GIS will significantly improve the ability to consolidate information and improve management and tracking of City owned buildings, properties and structures.
Parks Management	2, 4, 5, 6, 7, 8	a, b, d	Medium	Medium	Consolidate disparate information/data sets; Provide consistent information for parks management.
Parking Management	1, 2, 5, 6, 7, 8,	a, b, c	High	High	Parking management data in GIS will

GIS Return on Investment Analysis: Efficiency & Effectiveness Evaluation

Business Processes	GIS Problem Areas	GIS Benefit Areas	Efficiency Potential	Effectiveness Potential	Comments
	9				help improve management and tracking of parking ordinances and development restrictions related to on-street parking.
Pavement Mgmt.	1, 2, 3, 4, 5, 6, 7, 8, 9	a, b, c	High	High	Better management of current system.
Street System (centerline, signals, crosswalks, signage)	1, 2, 3, 4, 5, 6, 7, 8, 9	a, b, c,	High	High	GIS will help consolidate numerous databases and provide consistent street information used by multiple department business processes and systems.
Utility Mgmt.(water, sanitary, sewer)	1, 2, 3, 4, 5, 6, 7, 8, 9	a, b, c,	High	High	GIS will help improve efficiency in locating facilities, processing development permits, and responding to emergencies, such as breaks in water system.
Planning					
Demographics/Business Geographics	3, 5, 6, 7, 8, 9	a, b, c	Medium	Medium	Improve availability of data to multiple departments.
Land Use Planning	2, 3, 5, 6, 7, 8,	a, b, c, d	High	High	There are significant opportunities to improve efficiencies by integrating GIS with permit system.
Permitting/Development Review	1, 2, 3, 4, 5, 6, 7, 8, 9	a, b, c, d	High	High	There are significant opportunities to improve efficiencies by integrating GIS with permit system.
Transportation System Plan	1, 2, 3, 5, 7, 8, 9,	a, b	Medium	Medium	Help improve standardization of data and naming conventions.
Environmental					
Environmental Mapping	1, 2, 3, 4, 5, 6, 7, 8, 9	a, b, c	High	High	Improve access to environmental data; Improve communication

GIS Return on Investment Analysis: Efficiency & Effectiveness Evaluation					
Business Processes	**GIS Problem Areas**	**GIS Benefit Areas**	**Efficiency Potential**	**Effectiveness Potential**	**Comments**
					between departments related to environmental management.
Services					
Community Policing	1, 5, 6, 7, 9	a, b, c	High	High	Use GIS to monitor community policing progress more effectively.
Crime Analysis	1, 5, 6, 7, 9	a, b, c	High	High	Use GIS to more efficiently identify crime trends.
Crime Prevention	1, 5, 6, 7, 9	a, b, c	High	High	Use GIS to significantly increase currently level of service provided to public.
Disaster/Emergency Planning & Response	1, 2, 3, 4, 5, 6, 7, 8, 9	a, b, c	High	High	Use GIS to improve ability to respond during emergency situations, such as locating and tracking facilities, resources, and events, as well as communicate with other agencies.
Library Services	2	B	Medium	Medium	Potential to improve library educational outreach efforts by employing GIS, especially for school children.
Police Patrol	5, 6, 7, 9	a, b	Medium	Medium	Improve ability to tactically deploy patrol officers.
Public Safety	5, 6, 7, 9	a, b, c	High	High	Use GIS to significantly increase currently level of service provided to public.
Traffic Accident Monitoring	1, 2, 3, 4, 5, 7, 9	a, b, c	Medium	Medium	Moderate potential benefit to place information on external web site. Help better deploy traffic resources.
Traffic Monitoring	1, 2, 3, 4, 8, 9	a, b, c	Medium	High	High potential benefit to place information on external web site.
Urban Forestry	2	b	Low	Low	Some potential in mapping heritage

GIS Return on Investment Analysis: Efficiency & Effectiveness Evaluation					
Business Processes	**GIS Problem Areas**	**GIS Benefit Areas**	**Efficiency Potential**	**Effectiveness Potential**	**Comments**
					and street trees.
Administration					
Finance/Utility Billing	1, 2, 3, 4, 9	a, b	Medium	Medium	Moderate efficiency potential by integrating GIS with finance and utility billing system
GIS System Administration	1, 2, 3, 4, 7,9	a, b, c	High	High	High efficiency gains expected from being able to centrally manage, distribute, and integrate GIS data sets.

Summary

The quantitative benefit analysis provides a systematic process for assessing return on investment potential resulting from GIS enterprise implementation. The benefits included in this analysis are associated with primarily labor savings. Based on this evaluation and the identified efficiency gains, the enterprise GIS implementation has a high potential to produce a return on investment. This is supported not only by findings in this analysis, but by the literature review of other existing implementations.

Furthermore, as noted above, the evaluation of the quantitative side of the benefit analysis is only part of the picture. Other more intangible benefits described earlier can be realized and further help support the business case and demonstrate the value of GIS for the City.

The next chapter provides cost estimate information and a financial strategy for implementing enterprise GIS.

Chapter 6 GIS Cost Estimate & Finance Strategy

Sections covered in this chapter:

- Introduction
- GIS Cost Categories
- GIS Cost Estimate & Financial Strategy
- Risks
- Conclusion

Introduction

This chapter provides a financial analysis of costs associated with implementing an enterprise GIS. As has been mentioned repeatedly in this plan, GIS is more than just the technology; therefore this cost estimate looks at the total cost of GIS over a five year forecast period, including the software/hardware, planning, design, development, deployment, and maintenance and support of the system. This cost estimate is based on the best available information and has been reviewed by a consulting firm for verification and validation. Some costs, such as hardware and software are fairly straightforward to estimate, and others such as data conversion are rough estimates. This is because the GIS Needs Assessment phase, which will focus on data requirements, is yet to be completed. Once the GIS Needs Assessment is completed, it will be possible to assess the magnitude of the conversion effort and then adjust the cost estimate accordingly, if necessary.

GIS Cost Categories

In the evaluation of the City of Tigard's GIS, costs are divided into two types: implementation and maintenance, or program costs. Implementation costs are those costs associated with designing, developing, and deploying the initial enterprise GIS, essentially costs during the first three years. Maintenance costs are those associated with ongoing costs and maintenance of continuing enterprise GIS under a program. The table below identifies the categories within the implementation and maintenance costs. Note that some of the components are identified in each.

GIS Cost Categories	
Implementation Costs	
• Computer hardware	• Application development
• Computer software	• Database development
• Needs Assessment/System Design	• Data Conversion

Maintenance (Program) Costs	
• Hardware software maintenance/upgrades	• Staffing
• Data maintenance	• Supplies
• Training/Education	• Technology investments
• System support	• Application Development

GIS Costs Estimate and Financial Strategy

It is expected to take approximately two to three years to accomplish the objectives to implement an enterprise GIS at the City of Tigard. The proposed strategy is to develop the initial core enterprise GIS infrastructure within 24 months of approval of the GIS Strategic Plan, followed by key application development and integration with core business systems over the following 12 months. This will allow most all of the key components of the enterprise GIS to be constructed and allow immediate city-wide use as soon as possible. The three-year cost to establish the core infrastructure is estimated at $759,250. The total 5 year lifecycle cost, factoring in the cost of the GIS program, which includes staffing costs and ongoing maintenance costs, is estimated at $1,631,115. Cost estimates are based on the best available information given what is known about the current state of the City's GIS, related business systems, and spatial data. Costs estimates have been evaluated by a consulting firm for verification and validation.

The schedule to implement the core GIS infrastructure is spread across three years. Once the three year investment period is complete, the GIS program will incorporate costs through normal budgeting within the IT Division. Certainty of funding is critical for success of this project, especially during the implementation portion, since all of the components are linked.

GIS COSTS FORECAST						
Costs (1)	**FY06/07**	**FY07/08**	**FY08/09**	**FY09/10**	**FY10/11**	**Totals**
Implementation						
Phase 1 Strategy & Planning Phase 2 Analysis & Design (Partial)	$125,900					$125,900
Phase 2 (Remaining) Phase 3 Development Phase 4 Deployment		$528,350				$528,350
Phase 5 Production/Operation			$105,000			$105,000
Total Implementation Costs						$759,250
Maintenance (Program Costs)						
GIS Program	$101,500	$122,790	$184,987	$215,536	$247,052	$871,865
Total Costs	**$227,400**	**$651,140**	**$289,987**	**$215,536**	**$247,052**	**$1,631,115**

1. Costs do not include individual department business system enhancements with GIS.
2. Year to year costs adjusted for inflation (3%, based on Consumer Price Index)
3. Tigard staffing costs based on current City burden rates.

Risks

As with any major technology deployment there are risks associated with the implementation of an enterprise GIS. Fortunately, the City's delay in investing in enterprise GIS technology has put it in the position where it will not be developing 'bleeding-edge'. GIS technology is widely used and accepted, especially in the Portland metropolitan area. In addition, the technology the City will purchase will be based on standardized programming languages, open architecture, and will be primarily Commercial-Off-The-Shelf (COTS) software not requiring significant customization.

Most of the risk the City will face will be internal during development and management of the system. These include:

- *Data Conversion Costs*
  Data conversion is usually the most expensive component of a GIS implementation. Estimates in this GIS Strategic Plan are based on limited review of the current state of the City's data, in particular Public Work's utility data. The GIS Needs Assessment will provide a more accurate picture of the magnitude of the conversion effort. If it is found that the data conversion or data collection effort will be more considerable, then the cost-estimates may have to be refined.

- *Department Conflicts/Scope Creep*
  In the enterprise GIS model, one comprehensive system will be designed to serve all departments. In such a model, there will inevitably be varying opinions and conflicts in how the system is designed. While this is typical in any multi-department endeavor, during the enterprise GIS implementation it will be particularly important to manage the scope of work closely and develop change management procedures to ensure there are not excessive delays, excessive costs, or incidences of scope creep broadening the project beyond is original intent.

- *On-going Support/Coordination Requirement*
  An enterprise GIS will not persist, and subsequently not provide the intended return on investment, if it does not receive on-going management, coordination, and staffing as identified in this document. The technology is expensive and can provide significant cost-savings; however, it takes special and devoted personnel to ensure the savings are obtained.

- *Complex Technology*
  While the front end of many GIS are becoming more simplified and easy to use for the casual user, it is important to realize the technology behind the GIS is becoming increasingly complex. The City will need to acknowledge that certain skill sets identified in this GIS Strategic Plan will be required to keep the system at a certain level of operation. If these skill sets are not available, then the benefits again are likely not to be obtained. The GIS Strategic Plan will become an important component in establishing the required skill sets to sufficiently maintain the enterprise GIS (See Chapter 4 GIS Organizational Structure and Staffing).

Conclusion

The City does not need to be sold on the value of GIS as a new technology, having used it steadily for over 15 years. Despite the successes so far, however, the full utility for what GIS can provide has not been fully demonstrated up to this point. Aging systems, a lack of data access, incorrect address information, duplication of efforts, lack of strategic planning, and shifting priorities all characterize challenges of the current GIS environment. All of these issues speak to a larger need for a results-oriented, enterprise GIS focus that can remain in place over a period of time to follow-through and deliver results.

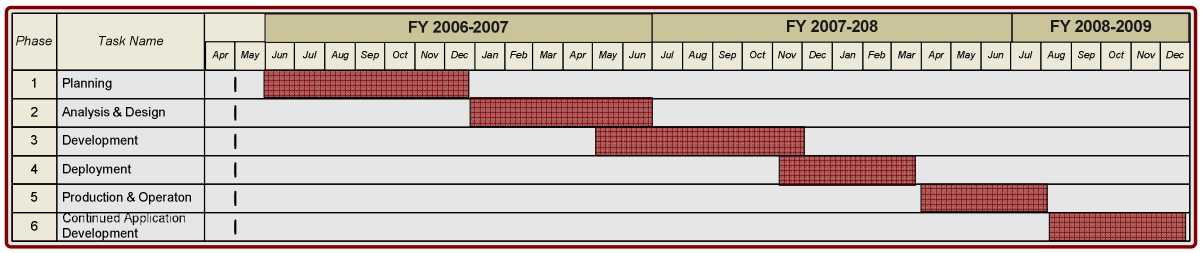
The enterprise GIS described in this plan will provide a focus and help the City to realize value from GIS technology beyond what any one department or individual can achieve. In truth, the City has already come to realize the value of this message by committing to the GIS strategic planning process and the development of this plan, a logical first step. Great efforts have been exerted to compile and develop a truly collaborative plan for GIS that has the consensual support of the individuals across the city who will later participate in the plan implementation.

The City has a unique opportunity before it to seize upon this momentum and develop GIS infrastructure that can be part of a suite of mission critical decision support tools. The impacts that would be felt to core business processes, internal efficiency and citizen service are unquestionably important and will have positive impact on City governance.

With Council support and approval for the recommendations in this document, the City will have taken the next step towards realizing the full potential for what GIS can provide to government and the community it serves.

Chapter 7 Schedule

The initial implementation of the City's enterprise GIS is expected to take approximately 2-3 years. Work on the GIS Strategic Plan commenced in May of this year. The targeted completion date is December of 2008. The schedule below shows the timeline of the 5 phases of the project. The timeline assume adequate funding is in place to begin the enterprise Needs Assessment in January 2007 and that appropriate budgeting has been established for the upcoming fiscal years.



Chapter 8 GIS Work Plan Outline

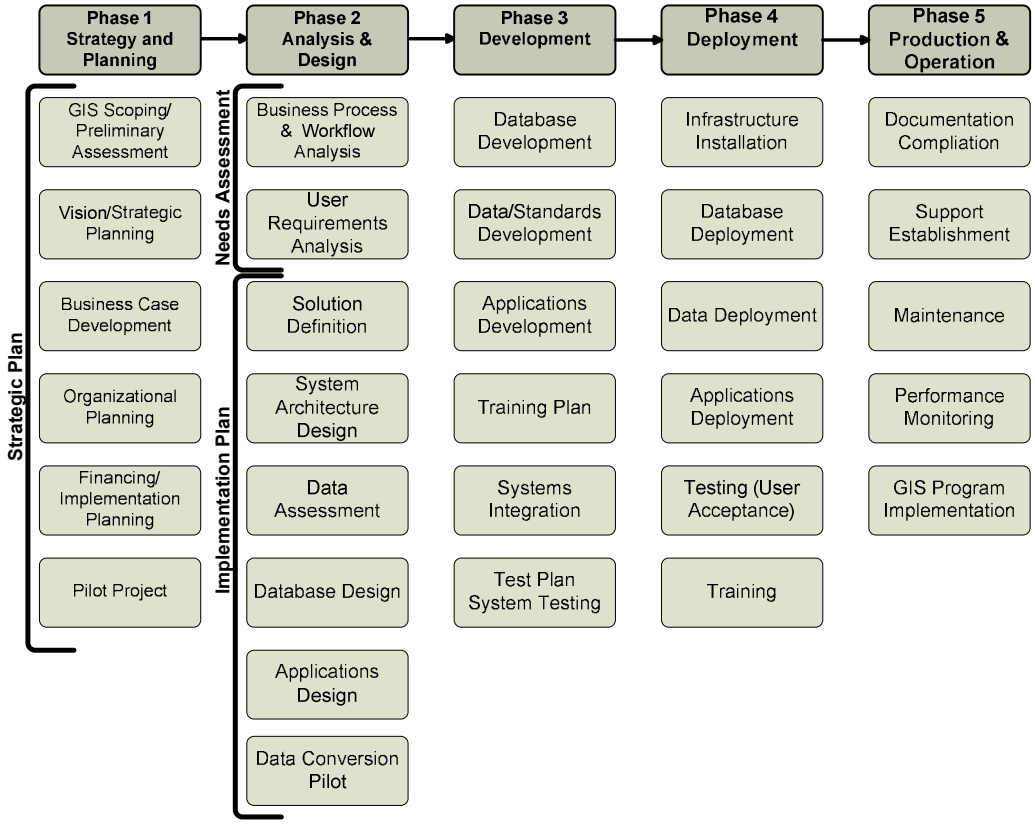
Sections covered in this chapter:

- Introduction
- Phase 1 Strategy & Planning
- Phase 2 Analysis & Design
- Phase 3 Development
- Phase 4 Deployment
- Phase 5 Production & Operation

Introduction

This chapter contains the proposed work plan for the City of Tigard's enterprise GIS implementation. The work plan uses a five phase approach to design, development, deployment, and implementation of the city-wide GIS. Upon successful completion of this five phase process, the City of Tigard will have established core enterprise GIS infrastructure capable of serving a much broader spectrum of users both internally and within the community than previously available under the current GIS.

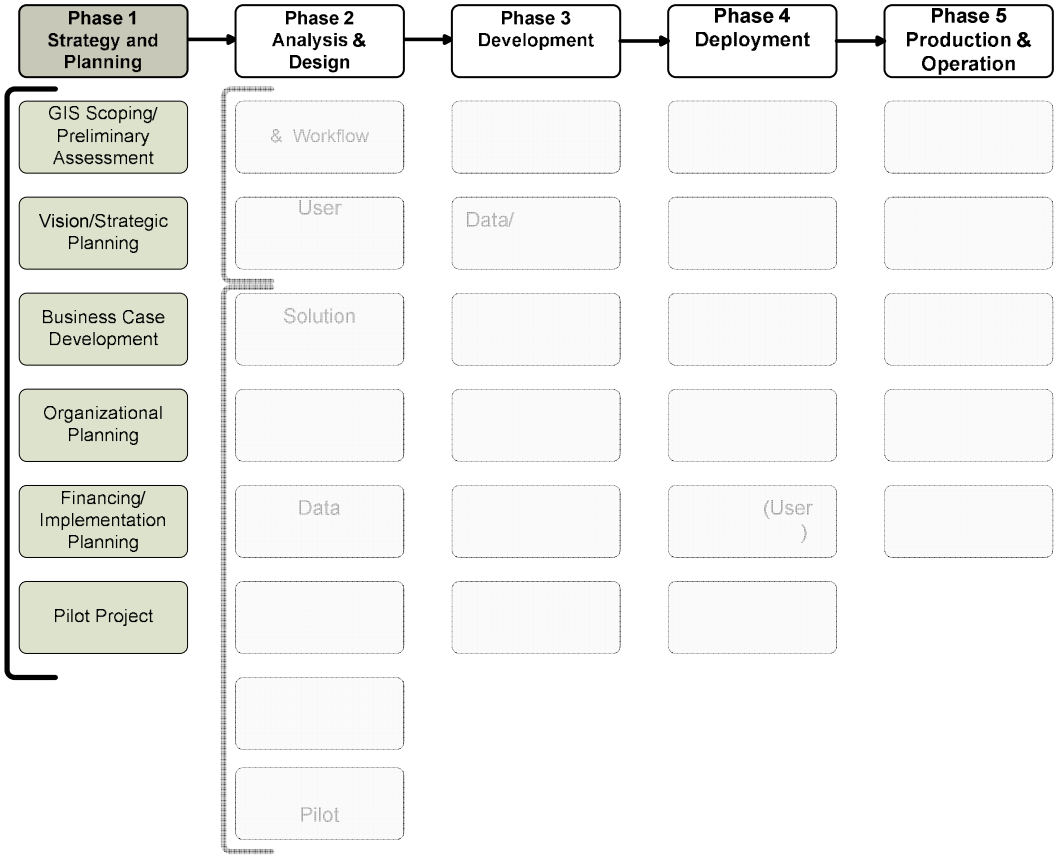
The five phases include:



The remaining part of this work plan is structured around the five phases and associated work areas within each phase.

Phase 1 Strategy and Planning

Purpose
Phase 1 represents the strategic planning portion of the enterprise GIS implementation. This phase establishes the overall direction for the enterprise GIS for the City of Tigard, including a vision, goals and objectives, business case justification, financing plan, and a pilot project. The first 5 activity areas shown below are complete and represent Chapters 1 through 7 in this document.



Phase 1 Activity Areas

1.1 GIS Scoping/Preliminary Assessment
This first activity area involves a preliminary assessment of the current environment at the City related to GIS.

Work Areas
1.1.1 Assess current environment (opportunities, constraints, challenges).
1.1.2 Research other similar agencies' GIS in the Portland area.
1.1.3 Research evolving trends and business needs.
1.1.4 Evaluate architecture and application choices.
1.1.5 Preliminary evaluation GIS integration capability with key business

processes.

1.1.6 Establish project organizational structure.

1.1.7 Identify and assemble 'GIS Steering Committee' members, establish roles and responsibilities.

1.1.8 Identify deployment timeline.

1.2 Vision/Strategic Planning

Enterprise programs require more planning, testing, and change management than desktop or workgroup solutions, and will have City-wide implications; therefore it is recommended that an oversight committee be established to help with planning efforts. With a 'Steering' committee on board, overall guiding goals and objectives can be established and key issues can be resolved and/or prioritized. The steering committee will also serve as representative or 'project champions' knowledge in many of the important issues surrounding the implementation of the enterprise GIS. It is anticipated that the committee will help serve as the main group of enterprise GIS promoters. Activity in this section includes:

Work Areas

1.2.1 Development of enterprise GIS goals and objectives.

1.2.2 Identify key issues facing enterprise GIS implementation, identify stakeholders responsible for decision-making these issues.

1.2.3 Identify high priorities for inclusion in enterprise GIS (e.g., mission critical systems, high priority data).

1.2.4 Develop conceptual GIS enterprise architecture model, primarily for communication purposes, demonstrate consistency with overall IT architecture.

1.2.5 Identify user groups.

1.2.6 Identify preliminary staffing requirements.

1.2.7 Evaluate potential need for outside technical expertise (consulting services).

1.3 Business Case Development

This activity involves documenting the cost/benefits associated with an enterprise GIS. While not every cost and benefit can be accounted for, specific examples of current business process can be used as examples to show how the process could benefit under an enterprise model.

Work Areas

1.3.1 Develop appropriate cost/benefit analysis.

1.3.2 Document other intangible benefits of enterprise GIS (e.g., improved customer service.

1.4 Organizational Planning/Communication

A variety of organizational and resource related issues will need to be addressed to ensure GIS implementation is congruent with the organizational structure, that GIS functions are understood by stakeholders, and to ensure GIS is effectively maximized within the agency. These include:

Work Areas

1.4.1 Define organizational structure of GIS within the organization.
1.4.2 Create detailed staffing requirements/recommendations.
1.4.3 Establish roles & responsibilities of user groups.
1.4.4 Create Communication Strategy for informing/sharing stakeholders and interested parties about status of Enterprise GIS.

1.5 Strategic Plan
This activity involves assembling the main planning document for enterprise GIS as well as budget and timeline for deployment.

Work Areas
1.5.1 Develop Enterprise GIS Technology Strategy 'Road Map' (implementation plan and timeline).
1.5.2 Develop enterprise GIS implementation budget, resource requirements.
1.5.3 Obtain approvals for plan and budget.

1.6 Pilot Project
A pilot project, or 'early win', will be an important milestone in the enterprise implementation by allowing an opportunity to show decision-makers and potential users where the project is heading with a real live tangible example and point out key benefits, value, and functionality of GIS.

Work Areas

Phase 1 (Intranet)

Project Initiation

1.6.1 Identify initial pilot project parameters (i.e., goals/objectives).
1.6.2 Coordinate with steering committee to identify pilot project candidates.

Needs Assessment

1.6.3 Determine end user environment for pilot project, including public access component.
1.6.4 Identify and document functional requirements of pilot project.
1.6.5 Identify and document technology needs with candidate project, including procedures and requirements for deploying web-based mapping application over Internet.
1.6.7 Research viable software applications to showcase pilot project.
1.6.8 Address Needs Assessment BP Mapping, database design.
1.6.9 Develop design document and refine cost estimates for GIS Pilot Project.

Development

1.6.10 Acquire software/hardware environment for pilot, including phase 2 environment.
1.6.11 Develop crime database access/download procedures, custom queries,

linkages.
1.6.12 Convert/develop and clean up address database.
1.6.13 Load crime data and test.
1.6.14 Acquire base map data, integrate into GIS.
1.6.15 Build and configure back-end environment.
1.6.16 Develop mapping environment.
t1.6.18 Develop standard report functionality.
1.6.19 Configure pilot.
1.6.20 Test pilot.

Deployment

1.6.21 Create demonstration format/strategy and present to interested/identified parties, including a strategy of how the external website component will be presented to the public.
1.6.22 Deploy pilot.
1.6.23 Conduct presentations/demonstrations internally.
1.6.24 Monitor usage/troubleshoot.

Phase 2 (External Website Deployment)

Development

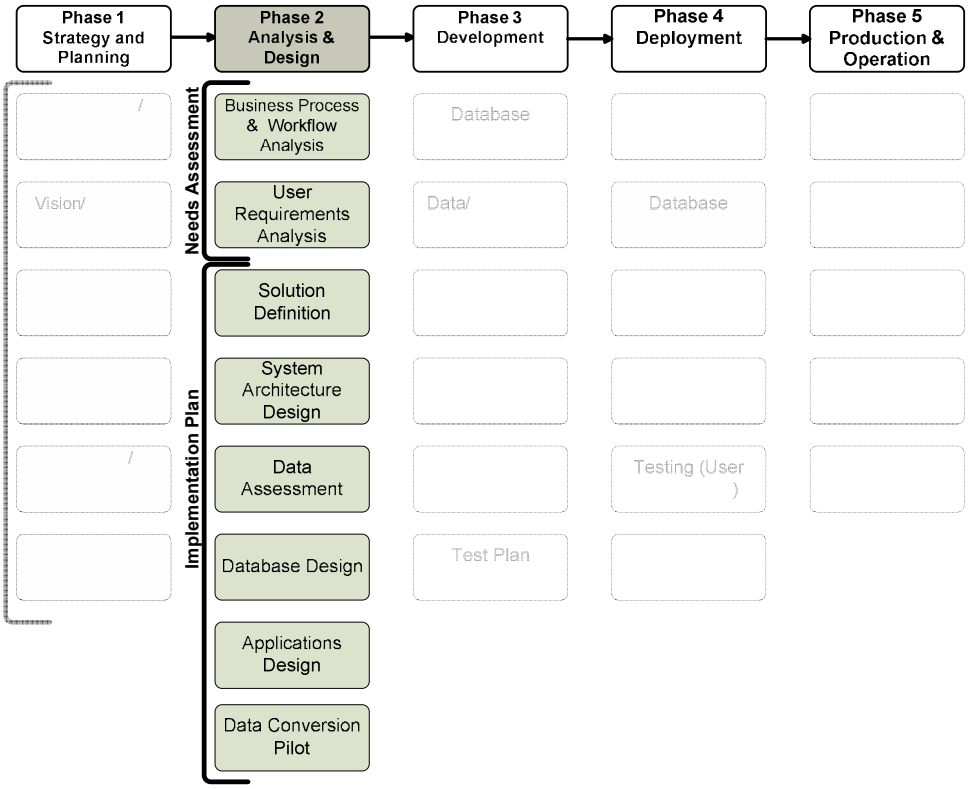
1.6.25 Develop design of Internet front end/web page.
1.6.26 Develop and configure hardware environment.
1.6.27 Build back end environment.
1.6.28 Update as necessary mapping environment.
1.6.29 Configure external pilot.
1.6.30 Build front-end web page.
1.6.31 Test Pilot.

Deployment

1.6.32 Deploy Pilot.
1.6.33 Monitor web activity/problems/issues, adjust as necessary.
1.6.34 Report back to Steering Committee on success of deployment.

Phase 2 Analysis and Design

Purpose
The Analysis and Design phase examines the business activities that can benefit from the use of GIS by analyzing business processes and workflows within the organization and document how geographic information is part of that workflow. From this documentation, solutions are identified and overall system blueprint with an enterprise focus is created. Additionally, rather than a department-centric focus, this method breaks out of the department silos and looks at all elements and participants involved in a particular business process.



Needs Assessment (Activity Areas 2.1 and 2.2)
The adoption of technological innovations such as GIS is not always a straightforward process. GIS in particular can introduce fundamental principles of change to an organization, especially in its thinking about geographic data.

In order to adequately grasp this fundamental principle of change and implement a successful GIS, a Needs Assessment is necessary. A Needs Assessment is a systematic look at how departments function and interact with geographic data in their daily work. Conducting a GIS Needs Assessment fosters cooperation and enhanced communication among departments by working together on a common technology and new set of tools. In addition to the final Needs Assessment report that is generated,

intangible benefits can be realized by the organization. Finally, the Needs Assessment activity itself serves as a learning tool where potential users in each participating department learn about GIS.

Without a complete Needs Assessment within the organization, GIS technology could be misapplied and fall short of achieving the benefits originally envisioned. If a coordinated effort is not initiated, that technology could be haphazardly applied and not integrated into daily workflow. Individuals and departments may adopt their own practices and procedures in trying to force their way into the technology, most likely in an inefficient manner.

At the conclusion of this Needs Assessment, the City will have all of the information needed to plan and develop an enterprise GIS, which will then be provided in the Implementation Plan document (see below) through work areas 2.3 thru 2.7. Information that will be gathered during the Needs Assessment phase can be grouped into the following categories:

- *Required GIS functionality*
  For a given department, certain GIS functions will be required, such as the standard operations of map look up display and print, query and display, standard reports with map, overlay analysis, buffering, other spatial analysis functions, and possibly advanced analysis requiring special programming.

- *Required GIS data*
  Most departments use data that involves a spatial component. This data can be paper based or tabular data sets that have a spatial identifier such as addresses and zip codes or X-Y values. A Needs Assessment will identify how this information can be used by GIS applications.

- *Special GIS Application Needs*
  In evaluating the responsibilities and workflow within an organization, certain tasks will be identified that can be done more efficiently or effectively in a GIS. These tasks will form the basis of GIS applications.

- *Procedures for maintaining GIS data*
  By looking at the workflow and processes within and between departments, responsibility for data creation, updates and maintenance will become apparent.

Once all Needs Assessment information is collected and analyzed for each department and published in a report, it will be used as the basis for the Implementation Plan or blueprint for implementing the GIS.

Implementation Plan

Activity Areas 2.3 through 2.8 comprise the Implementation Plan portion of the Phase 2 Analysis and Design Phase. The Implementation Plan represents the blueprint for the development of the GIS. This is where the individual needs and workflows are looked at collectively and a solution is developed. Of particular importance in this phase will be looking out how existing out-of-the-box software applications can best suit the GIS requirements, workflow requirements, and data maintenance and where there are gaps, as well as to what extent additional customization/integration is necessary. In addition

the data conversion pilot project will provide the opportunity to evaluate the complexities of converting the City's utility base.

Phase 2 Activity Areas
The following section lists the activity areas of Phase 2.

2.1 Business Process & Workflow Analysis
Business process analysis and modeling is an effective tool for defining the business activities associated with the use of GIS and when properly applied will greatly expand the organizational benefit of the enterprise GIS. The business process and workflow analysis outlined here will result in providing documentation of the existing business process ("as-is") and with the GIS technology ("to-be").

Work Areas
- 2.1.1 Consultant review of existing documents, systems, resources, and activities as they relate to GIS
- 2.1.2 Review and update business processes matrix.
- 2.1.3 Determine appropriate methodology/procedure/specific business process candidates for modeling business processes.
- 2.1.4 Create Business Process & Workflow Analysis Worksheets.
- 2.1.5 Set up pre-business process analysis orientation meetings.
- 2.1.6 Conduct workshops/interviews.
- 2.1.7 Compile information.
- 2.1.8 Create draft report.
- 2.1.9 Conduct follow up interviews as necessary.
- 2.1.10 Review & refine final report.

2.2 User Requirements Analysis

Work Areas
- 2.2.1 Prepare Needs Assessment approach.
- 2.2.2 Conduct Initiate pre workshop/interviews.
- 2.2.3 Conduct interviews/workshops.
- 2.2.4 Compile information and create Requirements document.

2.3 Solution Definition
The Solution Definition step represents the compilation, review, and synthesis of Needs Assessment and workflow analysis to arrive at an overall solution. This is an important step as it represents the shift from the evaluation and analysis of user requirements to resolve and the formulation of ideas, concepts, explanations that will reach the desired solution.

Work Areas
- 2.3.1 Identify potential software suite solution
- 2.3.2 Conduct Gap Analysis, evaluate out of the box limitations
- 2.3.3 Determine additional application development needs
- 2.3.4 Determine overall application environment that will do the best job at collectively addressing the identified application/workflow functions

2.4 System Architecture Design
Via the Needs Assessment, the current system architecture will be known as well as what is needed to adequately support a proposed enterprise system. System Architecture Design will provide the foundation for building a productive operational environment for enterprise GIS.

Work Areas

2.4.1 Review current system architecture
2.4.2 Develop overall System Architecture Design with upgrade recommendations, application specifications
2.4.3 Develop conceptual interface design
2.4.4 Develop proposed hardware/software Procurement Plan

2.5 Data Assessment
This work area will involve taking inventory of the current inventory environment and comparing it with the Needs Assessment findings to determine data gaps and issues. This work area also involves evaluating the condition of existing data and determining the appropriate steps to bring it into the planned GIS environment and also look at how the data will be managed once it is within the enterprise GIS environment

Work Areas

2.5.1 Conduct data assessment of existing data sets and determine data gaps, needs for additional data. Develop master Data Dictionary.
2.5.2 Develop overall map base model for classifying and grouping various data layers.
2.5.3 Develop Data Conversion/Migration Plan and prioritization scheme based on condition of data. Identify layers that are targeted for immediate upload into GIS database.
2.5.4 Develop Data Management Plan to address updates, uploads, transfers, replication, replenishment, backups, archiving, etc.

2.6 GIS Database Design –Conceptual/Logical Data Model

Conceptual/logical database design is the first step in database design where the contents of the intended database are identified and described allowing for a comprehensive mental framework and organized structure to be revealed. The conceptual design captures the user's view of the data and will allow the opportunity to evaluate how all of the various aspects interact (relationships), while at the same time providing the opportunity to identify major issues early on. This step uses information developed during the Needs Assessment and typically places it a structured format in the form of an Entity-Relationship Diagrams (ERD) or UML (Unified Modeling Language) diagrams.

The ERD or UML diagrams show the relationships between database tables and identify primary keys and important attributes. The purpose of the ERD or UML is to specify all tables and relationships needed to support the GIS applications. The conceptual design

process is iterative. It will identify items that are in existing databases that may need to be geocoded and included in the enterprise system. New attributes or entities will be discovered through interaction with staff and will require changes to the entities and their relationships.

Given the various states of spatial data within the organization, information that is currently maintained in GIS format or is maintained by other agencies, will not need to go through database design, but can proceed toward being integrated into the GIS database. Assuming the data meets the established standards (e.g., metadata standards, currency requirements) and is fairly isolated from other data (e.g., zoning layer, neighborhood boundaries), the data can be moved into the GIS database. Other layers such as those associated with utilities will need to go through database design stages.

Work Areas

2.6.1 Organize and prepare working groups/individuals for specific model(s).
2.6.2 Conduct meetings/interviews.
2.6.3 Develop logical data model(s).
2.6.4 Develop preliminary metadata requirements.
2.6.5 Review and validate w/ groups and update as necessary.

2.7 Application Design

Based on the Needs Assessment and Solution Definition, and in conjunction with the goals/objectives and established topology of User Groups within the City, the application environment can be identified. The GIS applications are those functions that GIS software performs, whether 'out-of the box' or through customization, using programming languages that will make the software useful to end-users. This activity will result in conceptual descriptions of the software applications recommended for development within Phase 3 Development.

This step should also include recommendations on priority application development given that not all application development will be covered in the initial core implementation.

Work Areas

2.7.1 Develop Application Design document with priority application development recommendations.
2.7.2 Review and comment.
2.7.3 Prepare final document.

2.8 Data Conversion Pilot

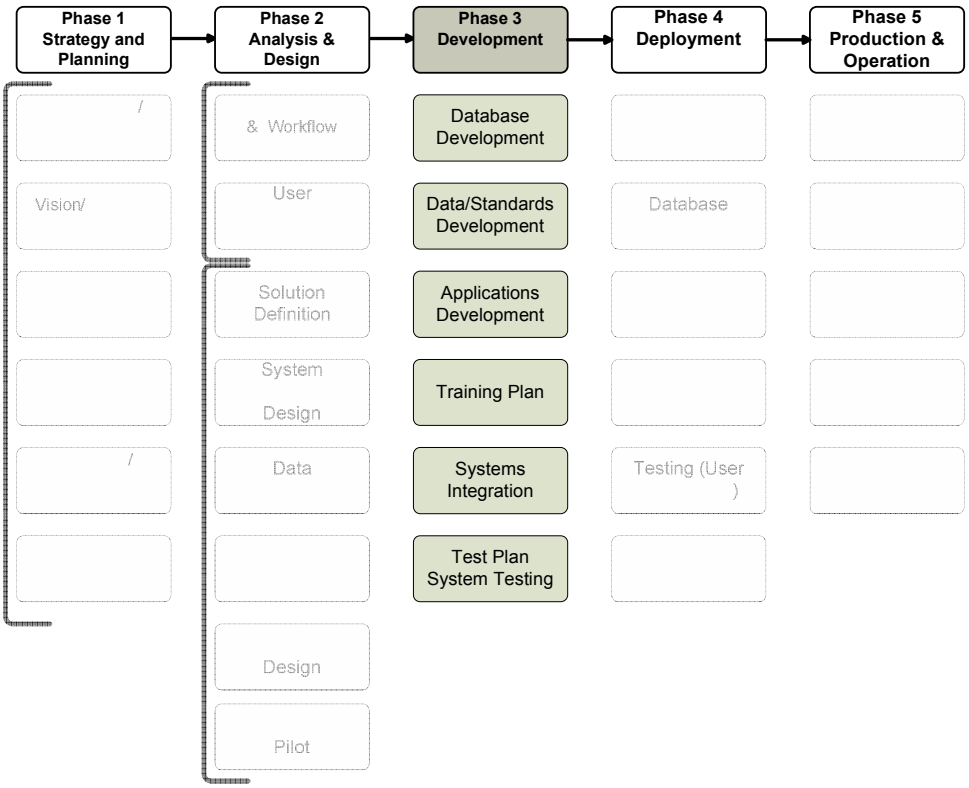
Given the complexity of the utility systems within Public Works and the unfamiliarity of the GIS data conversion process, a data conversion pilot project will be initiated. This will allow all participants to work through the entire conversion process and evaluate weakness/strengths/ and learn how to improve the remaining sets of utilities. The data conversion pilot project will include one of the three utility systems: water, sanitary, or sewer.

Work Areas

2.8.1 Identify candidate utility
2.8.2 Develop scope of work
2.8.3 Implement scope of work
2.8.4 Review and refine process to improve further data conversion efforts.

Phase 3 Development

Purpose
The Development phase is analogous to the construction phase of building a house. Design documents, or 'blueprints', from Phase 2 are used to begin actual database development, data conversion, and application development of the elements of the enterprise GIS.



Phase 3 Activity Areas

3.1 GIS Database Development –Physical Data Model
The physical model is built from the conceptual/logical model and is the process of implementing the data model schema within the geodatabase.

Work Areas
3.1.1 Develop physical database model(s).
3.1.2 Perform data conversion and migration based on Data Conversion/Migration Plan.
3.1.3 Initiate database set-up and administration.

3.2 Data/Standards Development

A Geographic Information System is more than hardware, software, and data. It also includes standards and procedures that enable the data and technology components of the system to work together efficiently. The City will be using data and sharing data from a variety of sources, both internal and external. This data may be stored in different formats, have varying levels of accuracy, use different map symbols, be produced on different schedules, be provided in different media, etc.. Although there are technological ways to deal with some of these variables, standards and procedures are necessary to ensure the City's data investment is protected and continues into the future. Standards and procedures serve as a corporate umbrella to promote data integrity and consistency. One of the more important standards will be metadata for individual data layers. These should be developed as the data layers are being created.

Work Areas

3.2.1 Create prioritized outline/list of standard and procedures to be developed.
3.2.2 Develop standards and procedures.
3.2.3 Review and test standards/procedures with stakeholders.
3.2.4 Develop single source location for easy access to standards and procedures.

3.3 Priority Applications Development

The City's enterprise GIS application development will be based on business requirements. Under this approach, business functions and user needs identified through the Needs Assessment drive the applications that are developed to support these specific functions and users. This insures that the system developed will be useful and will be used. Additionally, application development is the process by which the functional requirements of specific users are translated into software tools that support those functions. This requires that the functional requirements be transformed into detailed design specifications for application programmers.

Work Area*s*

3.3.1 Develop detailed design specifications for priority applications as recommended in the Application Design document. Specifications will include, but not limited to:

- Narrative description of what the application will do
- What business function the application will support
- A list of data inputs and outputs
- A list of menus and tools with descriptions of associated functionality
- Hardware and software requirements
- Diagrams illustrating screen layouts and data models
- Objective performance criteria that can be used to determine when the application is "complete."

3.3.2 Develop application prototype suitable for presenting, reviewing, test-run.
3.3.3 Verify alignment of applications with the functional requirements specified in the Needs Assessment.
3.3.5 Conduct testing as per Testing Plan.
3.3.6 Incorporate additional modifications to application and refine accordingly.

3.4 Training Plan

Training is considered a "critical success factor" in the implementation of enterprise GIS. It is important to develop a strategy for developing a training environment within the context of the existing structure, the topology of user groups, and tied to the goal of establishing a sufficient knowledge base within the organization. The Training Plan needs to encompass all personnel levels from within the organization from end users, to help desk personnel, to system and database administrators, and representatives from all levels of management, including decision-makers of GIS. The goal of this Training Plan is establish a blueprint to develop a 'critical mass' of knowledge, awareness and skills at the City so that the GIS program is successful.

Work Areas

3.4.1 Identify users that need to be trained
3.4.2 Identify the requirements that users will need to complete their work
3.4.3 Develop objectives and timelines for specific training phases
3.4.4 Evaluate relevant training options
3.4.5 Develop training program for each of the identified users
3.4.6 Develop single source location for easy access to training and knowledge base information.
3.4.7 Implement training necessary to complete components of Testing Plan

3.5 Systems Integration

GIS systems integration includes the work necessary to integrate spatial and non-spatial data from disparate technologies, applications, and business units for use in GIS. The City's GIS will be integrating with key business systems such as the public works asset management system. This step involves determining the process of integration with each of the different systems and will allow the ability to uncover potential integration issues and resolve them prior to the Deployment Phase.

Work Areas

3.5.1 Develop systems integration document.

3.6 Testing

Adequate testing will ensure enterprise GIS is delivered with the correct functionality and behavior as originally planned and designed.

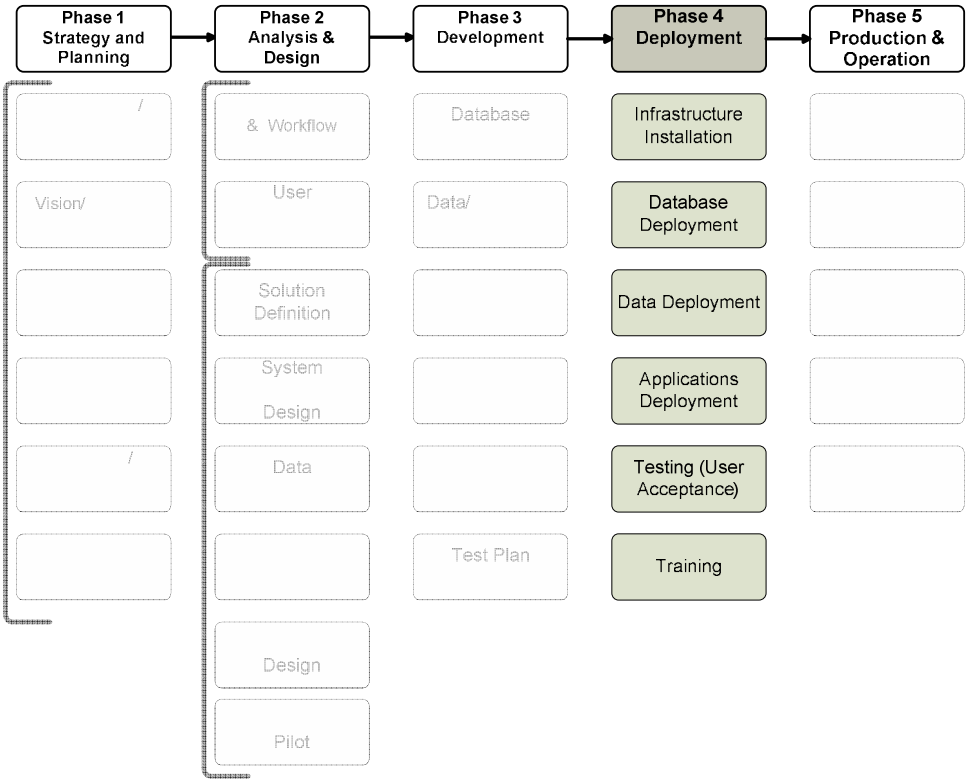
Tasks

3.6.1 Develop approach, scope, procedures, and acceptance criteria in Test Plan.
3.6.2 Conduct testing.
3.6.3 Debrief on testing, recommended actions/changes.

Phase 4 Development

Purpose
Deployment represents the phase in which the enterprise GIS will be physically installed and rolled out to the organization. Deployment will involve hardware, software applications, web-based applications, databases, the network, and personnel, and therefore needs to be closely coordinated to ensure an orderly deployment. To the extent possible a phased deployment should be coordinated so as to not create a situation of a 'single switch' event and run the risk of multiple problems emerging at once.

Up to this point in the GIS development process, the GIS hardware and software will have been acquired and data conversion completed (or a substantial portion has been finished). Different components of the hardware and software will also have been purchased. It is now necessary to put all the pieces together, test them to make sure they work as expected, and to initiate all procedures necessary to use the GIS.



Phase 4 Activity Areas

4.1 Infrastructure Installation

Work Areas

4.1.1 Develop infrastructure Deployment Schedule, including communication plan
4.1.2 Initiate infrastructure deployment

4.2 Database Deployment

Work Areas

4.2.1 Develop Database Deployment Schedule
4.2.2 Initiate Database Deployment

4.3 Data Deployment

Work Areas

4.3.1 Develop Data Deployment Schedule
4.3.2 Initiate data deployment

4.4 Priority Application(s) Deployment

Work Areas

4.4.1 Develop Priority Application(s) Deployment Schedule
4.4.2 Initiate priority application deployment

4.5 Testing

Work Areas

4.5.1 Using Testing Plan developed in Phase 3, conduct testing as planned.

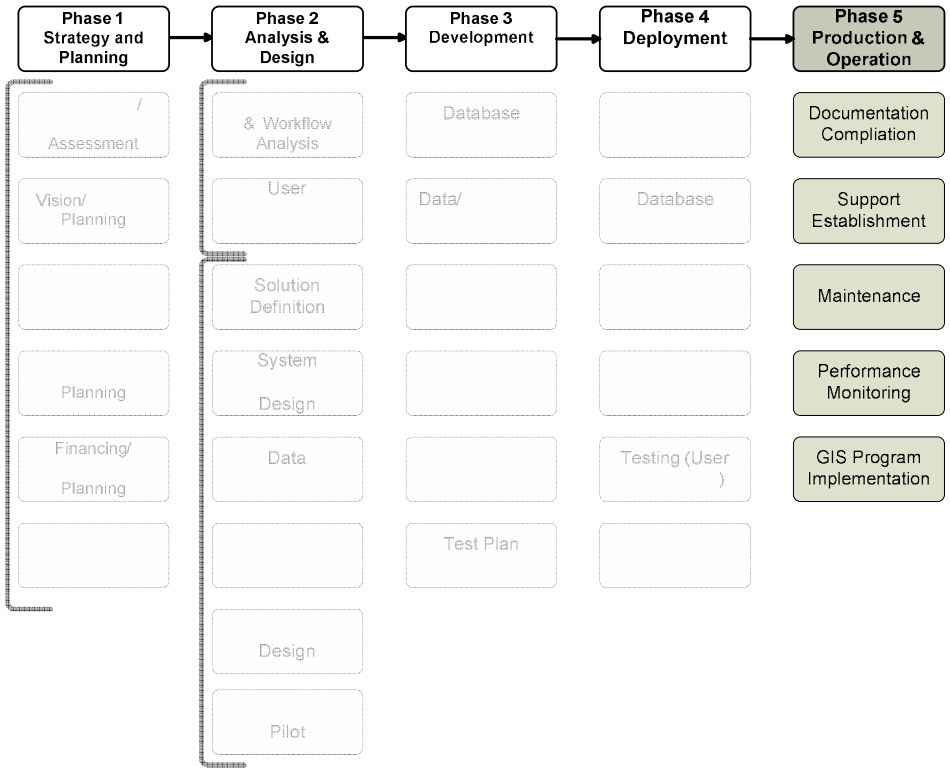
4.6 Training

Work Areas

4.6.1 Using Training Plan, conduct additional as planned. Note: training may occur prior to specific deployments.

Phase 5 Production and Operation

Purpose
The Production and Operation phase will lead to a successful maintenance, monitoring, support and service program for the enterprise GIS.



Phase 5 Activity Areas

5.1 Documentation Compilation

Work Areas

5.1.1 Assemble and inventory all identified required project documents
5.1.2 Complete remaining documentation.
5.1.3 Create single source resource location with easy access for relevant documents.

5.2 Support Established

Work Areas

5.2.1 As identified in Training Plan, initiate GIS support program for identified user groups.

5.3 Maintenance

Work Areas

5.3.1 Establish hardware/software maintenance program and lifecycle schedule.

5.4 Performance Monitoring

Once the system has been deployed, it will be important to determine what's working right, what could work better, and what additional capability needs to be developed.

Work Areas

5.4.1 Conduct post-project assessment workshop with project participants
5.4.2 Review and compile report with recommendations
5.4.3 Develop plan for continue performance monitoring.
5.4.4 Determine measures for performance optimization.

5.5 GIS Program Development/Implementation

This document(s) will address establishing the overall program and associated work plan for the City's GIS Program implementation.

Work Areas

5.5.1 Separate document/task list(s) to be prepared.

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Glossary

Attribute
1) A piece of information describing a map feature. The attributes of a ZIP Code, for example, might include its area, population, and average per capita income.
2) A characteristic of a geographic feature described by numbers, characters, images, and CAD drawings, typically stored in tabular format and linked to the feature by a user-assigned identifier. For example, the attributes on a well might include depth and gallons per minute.
3) A column in a database table. Attribute data is one of the two main types of data in a GIS (the other being spatial data).

ArcIMS
An Internet Map Server software application for developing and publishing interactive maps via the web (developed by ESRI).

ArcView
A desktop GIS application by ESRI.

Base map
A map depicting geographic features such as landforms, drainage, roads, landmarks, and political boundaries, used for locational reference and often including a geodetic control network as part of its structure. Examples include topographic and planimetric maps.

Desktop GIS
A geographic information system, such as ArcView GIS software, that runs on a personal computer.

ESRI
Environmental Systems Research Institute. A GIS software company.

FGDC (Federal Geographic Data Committee)
A federal government group coordinating spatial data collection.

Geodatabase
An object-oriented geographic database that provides services for managing geographic data. These services include validation rules, relationships, and topological associations. A geodatabase contains feature datasets and is hosted inside of a relational database management system.

GIS Geographic Information System
A Geographic Information System (GIS) is defined as an information system that is used to input, store, retrieve, manipulate, analyze and output geographically referenced data (location-based), in order to support decision making for planning and management of land use, natural resources, environment, transportation, urban facilities, and other administrative records.

GPS (Global Positioning System)
A system of twenty-four orbiting satellites used to determine location in three dimensions. The *Navstar* constellation of satellites transmits radio signals identifying satellite locations, which are used to determine a position on the Earth. *Navstar* is managed by the U.S. Department of Defense and available for civilian use, albeit with a degraded signal. GPS is used in navigation, mapping, surveying, and other applications where precise positioning is necessary.

Layer
A set of related map features and attributes, stored as a unique file in a geographic database. A GIS can display multiple layers (for instance, counties, roads, and hamburger stands) at the same time.

MAGIC
(Metropolitan Area Geographic Information Consortium). The existing desktop application used by the City of Tigard for generally look up and query of City geographic databases. (MAGIC was designed by Metro and is used with ArcView 3x)

Metadata
1) Data about data. For GIS data, metadata usually means data that is designed to help a prospective user find GIS data, determine whether is will serve a particular purpose, obtain the data, and use it.
2) Metadata consists of properties and documentation. Properties are derived from the data source, while documentation is entered by a person. By default, ArcCatalog automatically creates and updates metadata, which is stored as well-formed XML data in a file alongside the data or within a geodatabase. Metadata for a folder can also consist of a well-formed HTML file describing its contents.

Orthophoto
An orthophoto or orthophotograph is an aerial photograph that has been geometrically corrected ("orthorectified") such that the scale of the photograph is uniform, meaning that the photo can be considered equivalent to a map. Unlike an aerial photograph, an orthophotograph can be used to measure true distances, because it is an accurate representation of the earth's surface, having been adjusted for topographic relief, lens distortion, and camera tilt [source: Wikipedia].

Photogrammetry
Recording, measuring, and plotting electromagnetic radiation data from aerial photographs and remote sensing systems against land features identified in ground control surveys, generally in order to produce planimetric, topographic, and contour maps.

RLIS-Lite
Stands for Regional Land Information System. Metro's quarterly subscription of regional (Portland Metro area) geographic data layers.

Raster
Represents any data source that used the raster model to represent geographic information.

Raster data

One of three types of spatial data in a GIS (the others being image and vector data). Raster data represents geographic space as a matrix of cells. Map features are defined by numeric values assigned to the cells.

RDBMS (Relational Database Management System)
A database management system with the ability to access data organized in tabular files that can be related to each other by a common field. An RDBMS has the capability to recombine the data items from different files, providing powerful tools for data usage.

Shapefile
A shape file is the native ArcView spatial data format. In contrast to an ARC/INFO coverage, a shape file is a simpler, non-topological format which offers the advantages of faster display and the ability to be created or edited within ArcView. An ArcView shape file also serves as an effective interchange format for moving data in and out of ARC/INFO or other supporting software.

Spatial Data
Data that is represented in 2D or 3D images. Spatial data is information that describes the distribution of things upon the surface of the earth. In effect any information concerning the location, shape of, and relationships among, geographic features.

Topology
1) In geodatabases, relationships between connected features in a geometric network or shared borders between features in a planar topology.
2) In coverages, the spatial relationships between connecting or adjacent features (for example, arcs, nodes, polygons, and points). The topology of an arc includes its from- and to-nodes and its left and right polygons. Topological relationships are built from simple elements into complex elements: points (simplest elements), arcs (sets of connected points), areas (sets of connected arcs), and routes (sets of sections, which are arcs or portions of arcs). Redundant data (coordinates) is eliminated because an arc may represent a linear feature, part of the boundary of an area feature, or both.

Vector Data
One of three types of spatial data in a GIS (the others being image and raster data). Vector data represents geographic objects as points, lines, or polygons.

<u>*Sources*</u>*:*
Dictionary of GIS Terminology
Editing in ArcMap
GIS Data Conversion: Strategies, Techniques, and Management
INSIDE ArcView
Serving Maps on the Internet
Using ArcCatalog

Appendix A Communication Strategy

Sections covered in Appendix A:

- Introduction
- Communication Strategy and Purpose
- Success Factors
- Communication Media
- Content
- Groups
- Knowledge is Power

Introduction

Implementation of Tigard's enterprise GIS (Geographical Information Systems) will occur over the next 24 months. The project will have implications for most departments within the City. In order to ensure City staff and stakeholders are kept informed of the project and ensure a unified message is shared, a communication strategy is needed.

The communication strategy for the enterprise GIS project is designed to reach a spectrum of audiences, both technically focused and non-technically focused –decision-makers and non-decision-makers and ensure up-down, down-up and peer to peer communication about the project. Information shared through the communication strategy is primarily project information. Training of the actual software and or web-based applications will occur separately, and will be part of a training plan document to be produced later in the project.

Communication Strategy Purpose and Objectives

The following describes the purpose and objectives of the Communication Strategy:

Purpose

- Align communication activities with GIS project objectives;
- Ensure interested parties understand GIS project objectives;
- Establish a process to keep impacted users and stakeholders informed in a clear, accurate, and timely manner;
- Centrally manage the generation, distribution, storage, retrieval, and disposition of project information.

Objectives

- Identify various groups to communicate the project to and tailor information for these specific groups;

- Make information interesting and succinct. The project deals with technical information that can be difficult to understand, especially in regards to how end-users (clients) will be impacted. Understand the audience and modify the information accordingly. Let people know how they will benefit from GIS;
- Keep information regular and current;
- Ensure a primary contact person is established for managing project communication (GIS Coordinator);
- Be available to respond to questions and comments that will arise from sharing GIS project information.

Success Factors

The following success factors will be used to evaluate if the Communication Strategy achieves its objectives:

- Awareness –Targeted groups feel they have received adequate project updates
- Timeliness – Targeted groups feel they have received project updates in a timely manner
- Content – Targeted groups feel the content of the information was relevant to their specific group
- Format – Targeted groups feel information was understandable and easy to retrieve

Communication Media

Communication will take several forms. Depending on the type of group, the content of the information, and the timeliness of the delivery, the appropriate media will be used. These include:

- *E-mail Briefings*
  E-mail briefings will be short in nature, with links to other information or short documents with succinct messages. Information is generally meant to inform recipients of the project status or other pertinent information.

- *Paper Briefings*
  Paper briefings will be similar to above, but will be distributed in hard copy form. This is meant primarily for Council members.

- *Working Meetings*
  Working meetings are primarily for addressing items within the Strategic Plan, including specific tasks in the Work Plan.

- *Briefings in Person*
  Briefings in person include short updates on the status of the GIS project or other active issues associated with the project. Briefings will be usually 15-30 minutes.

- *Presentations in Person*
  Presentations in person include longer presentations on the status of the GIS project or may include informational topics, such as educating groups on GIS. These presentations will be greater than 30 minutes. For example, a brown bag presentation to City staff on GIS concepts is type of presentation in person.

- *Digital Project Notebook*
  The Digital Project Notebook will be a central repository of project related documents. The idea is to promote a one-stop-shopping location for information, a source where interested parties know where to go for the most up to date project information. It is anticipated the location of the digital notebook will be through TIG20 the City's internal intranet. Information is not expected to be private or confidential, but will be limited to City employees.

- *Internet*
  The City's Internet will be used for posting of general project information, mostly an overview and summary of the scope of the project. Some completed project documents suitable for public consumption may be posted after they have been completed. If the Pilot Project is made available to the public, it will be accessed through the City's Internet site as well.

Content

The following describes the type of content that will be produced during the course of the GIS project implementation:

- *Information/Educational*
  Informational/educational content will be geared to inform and raise awareness about the project or about GIS in general. This content will likely reach a broad range of users and will need to take into account the laypersons perspective of GIS.

- *Meeting Minutes*
  Meeting minutes will be created for meetings where key decisions are being made, such as the GIS Steering Committee or meetings involving consultants. The primary intent of meeting minutes is to briefly describe what was discussed and itemize specific action items so there is documentation and clarity to those involved.

- *Status Reports*
  Status reports will be brief memorandums detailing the status of the overall project, reporting on outstanding issues, and reporting on project budget, schedule etc.

- *Project Documents*
  Project documents are those documents which are identified as specific deliverables in the Work Plan. For example, the Strategic Plan will be a project document. Project documents will be usually issued as draft documents for review and comment before becoming finalized.

Groups

The following identifies the various groups associated with the enterprise GIS project and the types of communication that will be employed.

Group	Primary Communication Media	Frequency	Responsible Party
Steering Committee	• Working Meetings • E-mail Briefings • Digital Project Notebook	Monthly	GIS Coordinator
Executive Staff	• E-Mail Briefings • Briefings in Person • Presentations in Person	Bi-Monthly	IT Director/GIS Coordinator
Council	• Paper Briefings • Briefings in Person	At Executive Staff's direction	City Manager
City Staff	• E-mail Briefings • Presentations in Person • Digital Project Notebook	Bi-monthly	GIS Coordinator
Public	• Internet	Updated monthly	GIS Coordinator
Departments	• Briefings in Person • Presentations in Person	Once or twice during project	GIS Coordinator

Knowledge is Power

Finally, GIS in itself is very interesting. Most people are graphically oriented and are drawn to maps which present information. It's easy for people to say there are ready to embrace GIS technology. However, accompanying GIS is a significant amount of learning and understanding about how it works, and how it will function within the City. GIS can bring with it a considerable amount of technical jargon. This communication strategy will take this into account and adjust communications to the particular audience.

Likewise, these communications provide the opportunity to introduce the layperson to basic GIS concepts and help build the collective knowledge base within the organization.

Appendix B Change Management Plan

Sections covered in Appendix B:

- Introduction
- Minor and Major Changes

Introduction

The GIS Work Plan (Chapter 8) identified within the GIS Strategic Plan is a “living” document. Changes to the work plan are inevitable so it is important to have a plan and process in place to allow for continual adaptation and the ability to keep the project moving forward without slipping or stalling. Change management plans are similar to a “change order” or “contract amendment” and are generally limited to changes in scope, cost, or schedule. The purpose of this change management plan is to define the procedure and format that will be employed throughout the work plan implementation and to ensure a communication protocol is established for stakeholders so they are informed of changes.

Minor and Major Changes

The implementation of the work plan, schedule, and associated budget is a continual series of course corrections, mostly minor, but occasionally major ones. In order to limit overwhelming stakeholders with constant change notifications, only major changes will be circulated for notification and the minor changes be managed in a Change Log maintained by the project manager. The Change Log, stakeholders will be stored in a location where stakeholders will have easy access to. In terms of distinguishing between major and minor changes, major changes include:

- Changes affecting budget by more than $10,000
- Changes affecting schedule by more than 3 weeks
- Changes that affect identified deliverables
- Changes to approved consultant scopes of work

Appendix C Value Measure Methodology Results

Value Measuring Methodology –Intangible GIS Benefits										
Value Categories	**Departments/Groups**									
	Eng. Services	**Public Works**	**Com Dev**	**Police**	**Library**	**Admin**	**IT**	**Finance**	**Public**	**Other Gov'ts**
	H High Benefit			M Medium Benefit			L Low Benefit			
Data Quality –GIS provides sufficiently accurate data and information for users and provides known measures of accuracy, currency, and completeness.	H	H	H	H	H	H	H	L	H	H
Accessibility –Spatial data is easily accessible to city staff and public.	H	H	H	H	H	H	H	L	H	H
Timeliness –Information is available when it is needed.	H	H	H	H	M	H	H	L	H	H
Depth and Breadth –Full range of data layers and tool sets available for use when they are needed.	H	H	H	H	L	H	H	L	H	H
Asset Protection –Support for assessment of critical infrastructure elements, level of risk, and effective means for risk management.	H	M	M	H	L	H	M	L	H	H
Public Safety –System provides timely and accurate information for law enforcement,	H	H	M	H	L	H	M	L	H	H

Value Measuring Methodology –Intangible GIS Benefits										
Value Categories	**Departments/Groups**									
	Eng. Services	**Public Works**	**Com Dev**	**Police**	**Library**	**Admin**	**IT**	**Finance**	**Public**	**Other Gov'ts**
emergency medical response, and fire incident, planning and response; emergency planning, event management, and disaster mitigation.										
Natural Resource Management –Provides information to support planning and management of natural resources in a sustainable manner.	M	L	H	L	L	H	L	L	H	H
Information Integrity and Security –Provides data that conforms to established standards for liability, privacy, confidentiality, security, and business continuity. Information assets are protected from catastrophe loss or corruption.	H	H	H	H	H	H	H	L	H	H
Intergovernmental Interoperability – Information-sharing and integration among disparate systems and entities within government is easily accomplished. State-Regional-Local partnerships are encouraged.	H	M	H	H	L	M	M	L	M	H
Latent Benefit Opportunity –Provides foundation/impetus for creative	H	M	H	H	H	M	M	L	M	M

Value Measuring Methodology –Intangible GIS Benefits										
Value Categories	**Departments/Groups**									
	Eng. Services	**Public Works**	**Com Dev**	**Police**	**Library**	**Admin**	**IT**	**Finance**	**Public**	**Other Gov'ts**
problem-solving analysis capabilities.										
Improving Organizational Image –GIS supports City's image as responsible and dependable municipality managing its assets and providing information to public.	H	M	H	H	H	H	M	L	M	M
Improved Decision-making –More comprehensive information base available for problem-solving, especially at key decision-making levels.	H	H	H	H	H	H	M	L	M	M

Appendix D Current City of Tigard Data Layers

Boundaries
Annexation Approval Boundaries
City Limits
Waste Haulers
Police District Boundary
Police Grid Boundaries
Citizen Involvement Teams
School Districts
Water Districts
Tax Codes
Urban Growth Boundary (UGB)
Zip Code Boundaries
Urban Service Area
Neighborhood Boundaries
Neighborhood Watch Boundary
Tigard CBD
Census
1990 Census Tracts
1990 Census Block Groups
Total Households (1994)
Single Family Households (1994)
Multi-Family Households (1994)
Single Family/Multi Family Households (1994)
Household Forecasts (2015)
Employment Forecasts (2015)
Population (1994)
County Business
All Firms
Major Firms – 100 Plus Employees
Environmental
Contour Lines
Natural Areas
Soils
Familiar Places
All Development
Fire Stations
Schools

Civic Building, School, and Park Locations
Apartment Complexes
Images & Photos
1994 Photos
1996 Photos
1999 Photos
2000 Photos
2001 Photos
2002 Photos
2003 Photos
2004 Photos
Feb 2005 Photos
July 2005 Photos
USGS 7.5 Minute Quads – 1984
Color Shaded Relief
Land Use, Tax Lots, and Permits
Site Address/Multi Addresses
Zoning
Comp Plan
Parking Zones (A/B)
Parks
Approved Subdivision & Minor Partition Locations
Greenways
City Owned Properties
Other Publicly Owned Property
Region 2040
Property Sales Information
Tax lots
Urban Reserves Study Areas
Vacant Land -1996
Vacant Land –1995
Planned Development Overlay
Buildable Lands Inventory
Street & Transportation
Accidents
Existing Streets
Addressed Streets/Street Centerline
Street Right-of-Way Names
Tigard Transportation Plan Designations
Roadway maintenance Jurisdictions

Bike Routes
Trails
Bridges
Bus Lines
Bus Stops
County Functional Classification
Major Road
Sanding Priorities
Park & Rides
Railroads
On-Street Parking
Traffic Signals
Water & Wetlands
Metro Title 3 Hydrologic Features
Title 3 100 Yr Floodplain
Title 3 Wetlands
Title 3 Streams
Title 3 Stream Buffers
WACO 1974 Floodplain
1996 flood Inundation Line
FEMA Flood Plain
Rivers & Lakes
Streams
Watersheds
Wetlands
Riparian Setback Areas
USA (CWS) buffer
Zero Rise Flood Data
Safe Harbor Riparian Buffer
Other Themes
County Owner Properties
Election Results
Housing Authority Properties
Fire Hydrants
Residential Waste Franchises
Section Index Map
Quarter Sections
Annotation for GIS files
Building footprints
Overhead wires
Street lights
Water Meters
Water Quality Pond/Detention Pipes
Tree Inventory
Public Works Areas
Water Meter Reading Routes

Site Development
WSRC Boundary
WSRC Redevelopment Opportunities
WSRC Bus Lines
WSRC Railway
WSRC Open Space
WSRC Wetlands Update
WSRC Vegetation Communities
City wide DEM
Other Data Sets
Metro RLIS Data